Task 1D Report for the Powder River Basin Coal Review Current Environmental Conditions

Prepared for

Bureau of Land Management
Casper Field Office and
Wyoming State Office

Submitted by

ENSR Corporation
Fort Collins, Colorado

June 2005
(with errata)

TASK 1D REPORT
FOR THE POWDER RIVER BASIN COAL REVIEW
CURRENT ENVIRONMENTAL CONDITIONS

Prepared for

BUREAU OF LAND MANAGEMENT
CASPER FIELD OFFICE
and
WYOMING STATE OFFICE

Submitted by

ENSR CORPORATION
Fort Collins, Colorado

June 2005
(with errata)

ES.1 EXECUTIVE SUMMARY

This Task 1D Report for the Powder River Basin (PRB) Coal Review describes the existing environmental conditions in the PRB study area, with the exception of air quality, water resources, and social and economic conditions, which are presented in individual baseline (Task 1) reports. The descriptions of current environmental conditions in this report are based on published and unpublished information; information obtained from local, state, and federal agencies and industrial companies; and a compilation of past and present actions in the Wyoming PRB developed for the Task 2 Report for the PRB Coal Review. The past and present actions summarized in the Task 2 report include surface coal mines (currently 12 are active and 1 is temporarily inactive), power plants, railroads, coal technology facilities, major transmission lines, other mines, oil and gas development, major pipelines, reservoirs, and other industrial and non-industrial developments. Descriptions of the past and present activities identified in the Task 2 report were based on the most recent data available at the end of 2003.

For the purpose of this study, the Wyoming PRB study area comprises all of Campbell County, all of Sheridan and Johnson counties less the Bighorn National Forest lands to the west of the PRB, and the northern portion of Converse County. It includes all of the area administered by the Bureau of Land Management (BLM) Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the Thunder Basin National Grasslands (TBNG), which is administered by the U.S. Forest Service (USFS). State and private lands also are included in the study area. The area of potential effect for the physical, biological, and human resources analyzed in this study varies by resource and in some cases extends outside of this study area, as appropriate.

ES.2 CURRENT CONDITIONS

ES.2.1 Topography, Geology, Minerals, and Paleontological Resources

The study area for topography, geology, minerals, and paleontological resources generally includes all or portions of Campbell, Johnson, Sheridan, and Converse counties. It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area. It should be noted that some historical predictions of mineral production came from documents (BLM 1981, 1996) that analyzed mineral production in project areas defined differently from this study area. Some information concerning the mineral production history occurred outside of the defined study area; however, this information is presented because of the relevance to the study area. In addition, certain aspects of general geology (stratigraphy, structural geology) are discussed for the entire PRB, including Montana.

ES.2.1.1 Topography, Geology, and Minerals

The description of existing conditions in the PRB study area for topography, geology, and minerals primarily was based on the Final Environmental Impact Statement and Proposed Plan Amendment for the PRB Oil and Gas Project (BLM 2003a). The information presented in that document was updated based on other information sources, including Wyoming Oil and Gas Conservation Commission (WOGCC) on-line production data, public BLM documents, IHS Energy Services™ (IHS) well data, Wyoming State Geological Survey and United States Geological Survey (USGS) publications, other published documents, and the past and present action descriptions presented in the Task 2 Report for the PRB Coal Review (ENSR 2005a).

The PRB is located within the Upper Missouri Basin Broken Lands physiographic subprovince that includes northeastern Wyoming and eastern Montana to the Canadian border. The topography generally is of low to moderate relief with occasional buttes and mesas. The general topographic gradient slopes down gently from southwest to northeast with elevations ranging from 5,000 to 6,000 feet above mean sea level (amsl) on the southern and western portions of the basin to less than 4,000 feet amsl on the north and northeast along the Montana state line. The major drainages in the basin are the Tongue, Powder, Belle Fourche, and Cheyenne rivers. Most of the drainages in the area are intermittent and have flows during high precipitation events or during periods of snowmelt. The drainages are part of the upper Missouri River Valley drainage basin.

The PRB contains Phanerozoic rocks (younger than Precambrian) over 17,000 feet in thickness. These rocks range in age from Cambrian to Tertiary. In addition, there are unconsolidated alluvial and surficial deposits. Most of the rocks older than Tertiary outcrop along edges of the study area and also are found in the subsurface of the structural basin or are exposed along the margins of the basin. Unconsolidated Quaternary deposits consist of alluvium, terraces, colluvium, gravels, and pediments. Alluvial deposits generally are associated with alluvial valleys of the major rivers and tributaries.

The PRB is one of a number of structural basins in Wyoming and the Rocky Mountain area that were formed during the Laramide Orogeny. The basin is asymmetric with a structural axis that generally trends northwest to southeast along the western side of the basin (Flores et al. 1999). From the eastern margin of the basin, the rocks dip from 2 to 5 degrees to the structural axis. In addition to the major structural elements that define the basin, there are a number of folds on the western and southern margins of the basin. Much of the basin has very little internal structure, and the large area of west-dipping rocks east of the basin axis contains few, if any, major folds or dislocations. Earthquakes, landsides, and subsidence do not present a hazard in the PRB based on the lack of active faults in the study area (USGS 2004); the low risk of ground shaking in the region if a maximum credible earthquake were to occur (Frankel et al. 1997); and lack of evidence of subsidence, landslides, or other geologic hazards in association with coal bed natural gas (CBNG) production.

Most of the coal resources of the basin are found in the Fort Union and Wasatch formations. Although coals are present in the Wasatch, they are not as economically important as the coals in the Fort Union. The Tongue River Member of the Fort Union Formation contains most of the economically important coal zones. A number of coal seams have been identified and mapped in the Wyoming portion of the PRB. Coal stratigraphy is complex because of the nature of the environments in which coal was originally deposited. The Wyodak-Anderson coal produces from over 20 mines in the PRB (Stricker and Ellis 1999). Coal quality data from the Wyodak-Anderson coal indicate that the coal is subbituminous, generally low sulfur, and has low concentrations of metallic constituents. The low sulfur nature of the coal has made it valuable because of its cleaner burning characteristics for power generation. Often utilities will blend PRB coal with higher sulfur coals in order to achieve air quality emissions compliance.

Drilling for conventional (non-coal bed natural gas [non-CBNG]) hydrocarbon resources has declined considerably in the last 15 years (from a high of 199 in 1990 to 32 in 2003) averaging 100 wells per year for all categories of wells (production, injection, wildcats) (IHS 2004). However, there remains potential for locating and developing conventional oil and gas production in the deeper areas of the basin. The USGS (2002) estimates that the PRB (Wyoming and Montana) may have undiscovered hydrocarbon resources (mean) of 1.5 billion barrels of oil and 1.2 trillion cubic feet of gas (non-CBNG). Much of this resource may be in the deeper sparsely drilled parts of the basin.

Waning interest in oil can be seen in the decline of oil production. In 2003, conventional oil and gas production from the PRB was approximately 19.5 million barrels of oil and 47 billion cubic feet (BCF) of gas (WOGCC 2004). That compares with a production of 50.5 million barrels of oil and 64.4 BCF of gas in the PRB in 1989; CBNG production in 1989 was insignificant. Per IHS (2004) data, non-coal bed hydrocarbon production from the PRB study area in 2003 was 12.9 million barrels of oil and 40 BCF gas. There were approximately 3,500 active conventional oil and gas wells at that time in the PRB (not counting seasonally produced wells) (ENSR 2005a).

Total production for 2003 was 346 BCF, or 88 percent of the total gas production from the basin (WOGCC 2004); per IHS data, 2003 production was 338 BCF (ENSR 2005a). From 1987 to 2003, the total cumulative gas production from PRB coals was over 1.2 trillion cubic feet, and the total cumulative water production was approximately 2.3 billion barrels (ENSR 2005a). Annual CBNG production has increased rapidly from 1999 through 2002 and appears to have started to level off in 2003. Annual water production increased between 1999 and 2002, but started to decrease slightly in 2003.

Surface coal mining alters the topography in mining areas by causing changes in slope, lowering the general land surface, and changing the physical nature of the surficial materials and overburden. The topography is affected only where mining occurs. Oil and gas exploration and development alter the landscape through leveling the land surface for drilling pads and cutting and filling during road construction. Oil and gas development affects topography to a much lesser degree than coal mining; however, it is more widespread than coal mining.

Other mineral resources in the PRB study area include uranium, bentonite, clinker, and aggregate. Uranium is found in the Wasatch, Fort Union, and Lance formations. There are three defined uranium districts in the PRB: Pumpkin Buttes, Southern Powder River, and Kaycee (BLM 2003a). Numerous uranium mining sites were present in these districts, but were mined out or uneconomic. Uranium currently is mined in the Southern Powder River District at Smith Ranch and Highland/Morton Ranch. Uranium is produced by the in situ leach method at both locations (Harris 2003). Wyoming produced 1.6 million pounds of yellowcake (the raw uranium production material) in 2002. There are several bentonite localities in the PRB, and bentonite in the study area is mined at Kaycee, Wyoming (Wyoming Mining Association 2004). Clinker is formed when coal beds burn, and the adjacent rocks become baked. Clinker is used as road surfacing material and is found in extensive areas in the study area (BLM 2003a). Terrace and alluvial deposits associated with the larger streams in the study area are mined for sand and gravel. The more important aggregate mining localities are in Johnson and Sheridan counties (USGS 2003b).

ES.2.1.2 Paleontological Resources

Scientifically significant paleontological resources, including vertebrate, invertebrate, plant, and trace fossils, are known to occur in many of the geologic formations within the study area. These fossils are documented in the scientific literature, in museum records, and are known by paleontologists and land managers familiar with the area.

Most of the geologic formations exposed at the surface within the study area are exposed only along the margins of the PRB. The most widely distributed units are the Wasatch and Fort Union formations. The Morrison and Lance formations outcrop in the western portion of the basin; however, in the vicinity of the coal mines and CBNG activity in the eastern portion of the basin, these formations occur at depth. Within the study area, the highly fossiliferous White River Formation occurs only on Pumpkin Buttes in southwestern Campbell County.

The Wasatch Formation is the most geographically widespread formation in the study area and is the bedrock geologic formation exposed at the surface in most of the basin. Because surface exposures are mostly vegetated, the formations within the PRB historically have not been perceived to be as rich in fossils as nearby basins, such as the Bighorn and Wind River, which have extensive badland exposures. Nevertheless, the ubiquitous anthills in the basin contain locally abundant remains of small animal fossils (mouse to rabbit sized), which can be successfully sampled even in vegetated areas.

The Fort Union Formation is not as widely distributed as the Wasatch Formation, but occurs around the margins of the basin. This formation contains locally abundant fossil vertebrates, invertebrates, and plants, and displays an important time interval during the early Tertiary evolution of mammals.

No fossil localities in the Fort Union Formation within the study area were identified during the museum record search for this analysis; however, they do occur nearby in Montana.

ES.2.2 Soils and Alluvial Valley Floors

ES.2.2.1 Soils

The study area for the soils and alluvial valley floors (AVFs) resources includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. Soils in the PRB study area can be classified into three main soil orders: Entisols, Aridisols, and Mollisols. The most extensive soils are Entisols, which are recent soils occurring mainly on sloping topography where geologic erosion outpaces soil profile development or organic matter accumulation. They generally are low in plant nutrients and commonly have clay textures. Aridisols occur on extensive areas of gently sloping to nearly flat, more stable, topography. These soils commonly have low to moderate organic matter content and plant nutrients in the surface layer. They also have moderate to strong structural development within the surface and subsoil layers. Carbonates and salts generally have been leached by water to depths of 1 to 2 feet or more; this process produces a more fertile rooting zone, particularly when soil textures are loamy rather than sandy or clayey.

The least extensive group of soils is the Mollisols. These soils are the most fertile and have higher levels of organic matter and nutrients, particularly in the surface layer. Small areas of fluvial soils also occur in the PRB. These soils are located on gently sloping to flat drainage bottoms, and vary considerably in fertility depending on the source of alluvium. Fluvial soils low in salts and sodium tend to be very fertile and are the most productive in the basin. The maintenance of long-term soil productivity is a primary soil resource issue.

Survey information is available, at different levels of intensity and scales of mapping, for soils in the PRB. Order 3 county surveys have been completed by the Natural Resources Conservation Service (NRCS) for all counties except northern Johnson County, which currently is being mapped. More detailed soils information is available for all coal mine permit areas in the basin. This mapping was done at a more detailed Order 1-2 level of intensity and included substantial soil sampling for laboratory analysis and interpretation. These surveys were reviewed and approved by the Wyoming Department of Environmental Quality (WDEQ) as part of the mine permitting process. More general soils information is available from the STATSGO mapping for the State of Wyoming. STATSGO provides an all-inclusive, general description of soils in the basin, but it is too general for use in project-specific impact evaluations. Soil associations are used in the STATSGO mapping. This NRCS product is being used for this study because of the basin's large size and the lack of complete coverage by the county soil surveys.

Based on the dominant soil series for each STATSGO map unit in the PRB study area and their associated soil characteristics, as identified in published and unpublished NRCS surveys, areas with severe wind and water erosion hazards, severe shrink swell potential, high salinity and sodicity, poor revegetation potential, and prime or otherwise valuable agricultural soils were identified in the basin as follow (BLM 2003a).

- Soils with severe wind erosion hazard are present from the Wyoming/Montana state line south down the center of Campbell County to approximately 14 miles south of Gillette and along the Little Powder River. They also are present in much of Converse County.

- Severe and moderate water erosion hazard soils occur primarily along the southwestern corner of the basin in Johnson County where slopes of 25 to 40 percent and greater occur. These soils also occur along the northern and eastern borders of the basin as well as down the center along the Powder River and into Converse County.

- Soils with severe shrink/swell potential occur along the northern and western borders of the basin, on both sides of the Powder River, down the center of Sheridan and Johnson counties, in the eastern portion and entire southern half of Campbell County, and in small scattered areas of Converse County.

- Approximately 40 percent of the soils in the PRB study area are considered saline and/or sodic. Saline soils are located near the confluence of the Powder River and the South Fork of the Powder River and along the Belle Fourche River, Black Thunder Creek, and Little Black Thunder Creek.

- Soils often are not recommended for salvage on slopes greater than 40 percent. Soils with moderate and sever slope hazards (25 to 40 percent slopes and slopes greater than 40 percent, respectively) occur primarily along the southwestern corner of Johnson County and as small scattered areas throughout the basin.

- Soils with poor revegetation potential are located throughout the PRB study area except in the central portion of Campbell County.

- Portions of Sheridan County, Converse County, and the central portion of Campbell County contain prime agricultural soils. These soils also extend into Johnson County along the Powder River and Clear Creek.

Based on GIS analysis, as of the end of 2003, the existing development-related soil disturbance in the PRB study area was approximately 121,890 acres, of which approximately 51,107 acres of disturbance was related to coal mining activity (see **Table ES.2.2-1**). The primary soil associations impacted as a result of coal mine development have included the Renohill – Bidman – Ulm, Hiland – Vonalee – Maysdorf, Kishona – Shingle – Theedle, Bidman – Parmleed – Renohill, Wibaux – Rock Outcrop – Shingle, Shingle – Tassel – Rock Outcrop, and Haverson – Glenberg – Bone.

ES.2.2.2 Alluvial Valley Floors

AVFs consist of unconsolidated stream-laid deposits where water availability is sufficient for subirrigation or flood irrigation activities (Public Law 95-87). The WDEQ administers these AVF regulations for coal mining activities in Wyoming. Before leasing and mining can proceed, AVFs must be identified, because their presence can restrict mining activities. Coal mine-related impacts to designated AVFs generally are not permitted if the AVF is determined to be significant to agriculture. Conversely, if the AVF is determined not to be significant to agriculture, or if the permit to affect the AVF was issued prior to the effective Surface Mining Control and Reclamation Act date,

the AVF can be disturbed during mining but must be restored to essential hydrologic function during reclamation. Currently identified AVFs are described for all coal mines in the PRB study area, based on individual mine State Decision Documents.

Table ES.2.2-1
Existing Soil Disturbance in the PRB Study Area[1]

Subwatershed	Total Disturbance[2]	Coal Mine-related Disturbance
Antelope Creek	19,807	13,785
Clear Creek	4,405	0
Crazy Woman Creek	494	0
Dry Fork Cheyenne River	1,684	0
Lightning Creek	2,900	0
Little Bighorn River	64	0
Little Missouri River	163	0
Little Powder River	17,896	8,018
Middle North Platte River	561	0
Middle Powder River	2,297	0
Middle Fork Powder River	259	0
North Fork Powder River	0	0
Salt Creek	1,225	0
South Fork Powder River	313	0
Upper Belle Fourche River	37,148	15,578
Upper Cheyenne River	16,656	13,726
Upper Powder River	12,444	0
Upper Tongue River	3,574	0
Total	**121,890**	**51,107**

[1]Based on GIS analysis of existing development-related disturbance as of end of 2003.
[2]Inclusive of coal mine-related disturbance.

Source: ENSR 2005b.

For this study, Wyoming coal mines were grouped into four areas based on geographic distribution within the basin, including: 1) Subregion 1, mines near Gillette and extending to the north; 2) Subregion 2, mines south of Gillette and north of Wright; 3) Subregion 3, mines east of Wright and extending to the south into the northern part of Converse County; and 4) Subregion 4, mines historically operating north of Sheridan to the Wyoming/Montana state line.

AVF areas were identified on mines in Subregion 1 including the Buckskin Mine, Eagle Butte Mine, former Fort Union Mine (now part of Dry Fork Mine), and Rawhide Mine. AVFs were not identified on the Hay Creek Amendment Area of the Buckskin Mine or on the Wyodak Mine permit area. Mine plan and reclamation features to prevent long-term impacts and the maintenance of essential hydrologic function for declared AVF areas are contained in various sections of each mine's permit document.

AVF areas were identified on mines in Subregion 2 including the Belle Ayr Mine, Caballo Mine, and Caballo Rojo portion of the Cordero-Rojo Mine. No AVFs were identified on the Cordero portion of the Cordero-Rojo Mine, or on the Coal Creek permit area.

AVFs were identified on mines in Subregion 3 including the Antelope Mine, Black Thunder Mine, Jacobs Ranch Mine, and North Antelope/Rochelle Mine. No AVFs were identified on the North Rochelle Mine or the former Dave Johnston Mine, which is located to the southwest of Subregion 3.

AVFs were identified in the permit areas for all of the former surface coal mines in Subregion 4, including Public Service Company of Oklahoma's Ash Creek Mine, Big Horn Coal Mine, and the Welch No.1 North Mine.

ES.2.3 Vegetation Including Wetlands and Riparian Areas

ES.2.3.1 General Vegetation

The study area for vegetation (including wetlands and riparian areas) includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area.

The PRB study area is characterized as a mosaic of general vegetation types, which include prairie grasslands, shrublands, forested areas, and riparian areas. These broad categories often represent several vegetation types that are similar in terms of dominant species and ecological importance. Wyoming Game and Fish Department (WGFD) land cover classifications mapping and Gap Analysis Project resources generated by the USGS Biological Resources Division were used to identify specific vegetation types within the PRB study area. Fourteen vegetation types were identified, of which 10 primarily consist of native vegetation and are collectively classified as rangeland. These vegetation types include short-grass prairie, mixed-grass prairie, sagebrush shrubland, other shrubland, coniferous forest, aspen, forested riparian, shrubby riparian, herbaceous riparian, and wet meadow. The remaining vegetation types support limited or non-native vegetation and include cropland, urban/disturbed, barren, and open water.

The short-grass prairie vegetation community accounted for 41 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community represents very sparse, sparse, and thin dry herbaceous rangeland types, as defined by WGFD. Short-grass prairie occurs on drought-prone, mildly alkaline, medium- and fine-textured soils. Few shrubs grow consistently in short-grass prairie, because the soils are too dry and compacted to support them. The mixed-grass prairie vegetation community accounts for 20 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community is a combination of low, medium, and high herbaceous rangeland types, as defined by WGFD.

The sagebrush shrubland vegetation community accounted for 28 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community includes a combination of sparse,

moderately dense, and dense Wyoming big sagebrush with a variety of understory grasses and forbs. The sagebrush shrubland is widely distributed and occupies a large proportion of the PRB study area. The other shrubland vegetation type accounts for 2 percent of the pre-disturbance vegetation in the PRB study area. This vegetation type is composed of three distinct shrub-dominated plant communities: mountain-mahogany shrubland, mixed foothill shrubland, and greasewood shrubland.

The coniferous forest vegetation community accounted for 2 percent of the pre-disturbance vegetation in the PRB study area. Juniper and pine forests tend to be lower in elevation, while spruce and fir forests occur at higher elevations. This vegetation community occurs primarily along the western edge of the PRB study area, where the upper-elevation conifer species are more common and in the northeastern corner where the lower elevation species are more common.

The aspen vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the PRB study area. Aspen communities typically occur in depressions, ravines, valley bottoms, or on the lee sides of ridges. Aspen seedlings are intolerant of drier conditions, and, therefore, this community distribution typically is dictated by the availability of soil moisture. The understory of the aspen vegetation community has greater productivity and species diversity than any other forested upland vegetation type in the PRB study area (Mueggler 1985). Many stands of aspen are a seral (i.e., transitional) community that would have conifers of various ages growing within them. In the PRB study area, this vegetation type is limited to the Big Horn Mountains.

The agricultural vegetation type accounted for 1 percent of the vegetation cover in the PRB study area. This land cover type is defined as croplands that are plowed or planted. These areas also may include wooded or shrubby draws and riparian areas. Agricultural areas are most common along the eastern edge of the Big Horn Mountains, along the major drainages, and near Wright and Gillette.

The urban/disturbed category accounted for less than 1 percent of the surface area in the PRB study area. This category includes lands covered by homes, businesses, streets, and a portion of the unvegetated surface mining areas present in the PRB. It is most common around cities and towns and along the eastern edge of the PRB study area where many coal mines are located.

The barren category accounted for 1 percent of the surface area in the PRB study area. This cover type includes rock outcrops, roads, sandbars, eroded gullies, and areas with less than 10 percent ground cover and perennial snow and ice areas, as defined by WGFD. It occurs as small, scattered areas throughout the PRB study area, and as several large blocks in the southwest portion.

The water category accounted for less than 1 percent of the surface area in the PRB study area. This category includes lakes, ponds, streams, and open water in wetlands, as defined by WGFD, and is scattered throughout the PRB study area.

Wetland and riparian areas are highly important water-related features in the arid landscape of northeastern Wyoming. Wetland and riparian areas occur throughout the PRB study area in all 18 subwatersheds and typically are restricted to the lands immediately surrounding major and minor rivers, streams, creeks, draws, topographical depressions, lakes, and ponds. Four riparian and wetland vegetation types have been identified in the PRB study area, including forested riparian, shrubby riparian, herbaceous riparian, and wet meadow.

The forested riparian vegetation community accounted for less than 1 percent of the vegetation in the PRB study area. This vegetation community is characterized by a variety of deciduous and coniferous tree species that occur along riparian areas, as defined by WGFD. Coniferous forested riparian areas are rare, occurring only in the foothills of the Big Horn Mountains along the western edge of the PRB study area. Deciduous forested riparian areas are much more common and occur throughout the PRB study area.

The shrubby riparian vegetation community accounted for less than 1 percent of the vegetation in the PRB study area. This vegetation community includes a variety of shrubs and herbaceous plants that exist adjacent to draws, gullies, and streams.

The herbaceous riparian vegetation community accounted for less than 1 percent of the vegetation in the PRB study area. This vegetation community consists of a variety of riparian moist grasses, sedges, and rushes. Herbaceous riparian vegetation occurs near drainages including rivers, streams, and creeks.

The wet meadow vegetation community accounted for 2 percent of the vegetation in the PRB study area. This vegetation community is a combination of green and very green herbaceous rangeland types, as defined by WGFD. Wet meadow is a grassland vegetation community that typically occurs on fine-textured soils in valley bottoms where the water table is high enough to saturate the soil during a portion of the growing season. In addition, this vegetation community commonly occurs where springs emerge, along reservoirs, and in irrigated pastures (Knight 1994).

Based on GIS analysis, as of the end of 2003, the existing development-related disturbance to vegetation communities (less riparian and wetland vegetation) in the study area was 119,800 acres, of which 50,790 acres of disturbance was related to coal mining activity (see **Table ES.2.3-1**) (ENSR 2005b). The primary vegetation communities impacted as a result of coal mine development have included mixed-grass and short-grass prairies and sagebrush shrublands. The existing development-related disturbance to wetland and riparian areas in the study area, as of the end of 2003, was 2,090 acres, of which 317 acres of disturbance was related to coal mining activity (see **Table ES.2.3-1**) (ENSR 2005b). The primary wetland/riparian communities impacted as a result of coal mine development have included shrubby riparian and wet meadows. Based on the Task 2 database, as of the end of 2003, approximately 136,284 acres of previously disturbed vegetation had been reclaimed, inclusive of approximately 21,238 acres of vegetation disturbance in previously mined areas (ENSR 2005a). It is assumed that the species composition on reclaimed land is different than surrounding undisturbed lands, particularly in regard to the percent of woody shrub species during the early years following reclamation.

ES.2.3.2 Invasive and Non-native Species

Once established, invasive and non-native plant species can outcompete and eventually replace native species, thereby reducing forage productivity and the overall vigor of existing native plant communities. Noxious weeds occur throughout the PRB study area. Their occurrence, distribution, and density are variable and are influenced by many factors, including disturbance type and frequency, climatic conditions, soil conditions, and local management efforts. Noxious weed lists are maintained by the Wyoming Department of Agriculture and by county weed and pest districts. Data relative to known noxious weeds or species of concern occurrences are scarce. A total of

22 noxious weed species and invasive species of concern are known to occur in the PRB. Although data relative to known occurrences of noxious weeds in the PRB study area are scarce, the actual occurrence potential is assumed to be commensurate with the type and frequency of disturbance and the site-specific reclamation and weed control measures that currently are or would be implemented.

Table ES.2.3-1
Vegetation Disturbance in the PRB Study Area[1]

Vegetation Community	Total Disturbance[1]	Coal Mine-related Disturbance
Cropland	750	12
Aspen	0	0
Barren	2,634	1,678
Coniferous Forest	584	299
Forest Riparian	13	0
Herbaceous Riparian	71	0
Mixed-grass and Short-grass Prairie[3]	70,735	29,117
Other Shrublands	253	0
Sagebrush Shrublands	42,770	19,213
Shrubby Riparian	404	212
Urban/Disturbed	19	0
Open Water	2,055	471
Wet Meadow	1,602	105
Total	**121,890**	**51,107**

[1]Based on GIS analysis of existing development-related disturbance as of end of 2003.
[2]Inclusive of coal mine-related disturbance.
[3]The GIS files do not distinguish between mixed-grass and short-grass prairie communities; they are combined.

Source: ENSR 2005b.

ES.2.3.3 Special Status Species

A total of eight special status plant species were identified as potentially occurring within the PRB study area, including one federally threatened species, six BLM sensitive species, and one USFS sensitive species. No WGFD sensitive species were identified in the PRB study area.

Ute ladies'-tresses orchid (*Spiranthes diluvialis*) is listed as federally threatened (USFWS 1992). In Wyoming, the Ute ladies'-tresses orchid is known from the western Great Plains in Converse, Goshen, Laramie, and Niobrara counties. Rangewide, the Ute ladies'-tresses orchid occurs primarily on moist, subirrigated, or seasonally flooded soils in valley bottoms, gravel bars, old oxbows, or floodplains bordering springs, lakes, rivers, or perennial streams at elevations between 1,780 and 6,800 feet above mean sea level (Fertig 2000a). In Wyoming, this species is known from four occurrences, all discovered between 1993 and 1997 (Fertig 2000b). As reported by Fertig (2000b), the only population known to occur within the PRB study area is located in Converse County, along a tributary of Antelope Creek. The BLM Casper Field Office administers the land at this location. This population is characterized as stable, with the number of observed individual plants varying between 11 and 35 during the period between 1990 and 1994.

The Laramie columbine (*Aquilegia laramiensis*) is a BLM sensitive species. Although no documented occurrences within the PRB study area have been identified, this species may occur in the area within suitable habitats.

The Porter's sagebrush (*Artemisia porteri*) is a BLM sensitive species. The species is endemic to Wyoming and is restricted to the Wind River and Powder River basins in Fremont, Johnson, and Natrona counties (Fertig 2000a). One of the documented populations in southwestern Johnson County is within the PRB study area. This species also may occur in other suitable habitats within the PRB study area.

The Nelson's milkvetch (*Astragalus nelsonianus*) is a BLM sensitive species. Three populations are known from Johnson County, two of which are located in the eastern portion of the county and within the PRB study area. This species also may occur in other suitable habitats within the PRB study area.

The many-stemmed spider-flower (*Cleome multicaulis*) is a BLM sensitive species. This species is known from a single extant site in Natrona County (Fertig 2000f). Based on the species distribution, it is not expected to occur within the PRB study area.

The Williams' wafer-parsnip (*Cymopterus williamsii*) is a BLM sensitive species. This species is known from 23 extant populations found in the limestone or talus outcrops of the Big Horn Mountains (Fertig 2000g). It may occur in suitable habitats in Johnson County and other suitable habitats within the PRB study area.

The Laramie false-sagebrush (*Sphaeromeria simplex*) is a BLM sensitive species. All of the known populations in Converse County occur in the southern portion of the county and south of the southern extent of the PRB study area. Based on the species distribution, it is not expected to occur within the PRB study area.

Barr's milkvetch (*Astragalus barrii*) is a USFS sensitive species. Twelve known populations occur in the PRB study area. Based on its distribution, the species may occur in suitable habitats within the PRB study area.

ES.2.4 Wildlife, Fisheries, and Habitat-related Values

The study area for wildlife and fisheries and related habitat values includes all or portions of Sheridan, Johnson, Campbell, and Converse counties, including BLM-administered and USFS-administered lands and state and private lands.

ES.2.4.1 Wildlife

General Wildlife

Wildlife habitat has been affected by past and present activities in the PRB study area. These disturbances include, but are not limited to, agriculture, mining, roads and railroads, urban development, oil and gas well pads, compressor sites, and other ancillary facilities. Key issues for wildlife, fisheries, and related habitat values in the PRB study area as a result of mineral and

industrial development can be classified as short-term and long-term. Potential short-term impacts arise from habitat removal and disturbance associated with a project's development and operation (e.g., coal mines, CBNG wells, etc.) and would cease upon project completion and reclamation in a given area. Long-term impacts consist of permanent changes to habitats and the wildlife populations that depend on those habitats, irrespective of reclamation success, and habitat disturbance related to longer term projects (e.g., power plant facilities, rail lines, etc.). Direct impacts to wildlife populations as a result of development could include limited direct mortalities, habitat loss or alteration, habitat fragmentation, and animal displacement. Indirect impacts could include increased noise, additional human presence, and the potential for increased vehicle-related mortalities. The severity of both short- and long-term impacts would depend on factors such as the sensitivity of the species impacted, seasonal use patterns, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, and climate).

Habitat fragmentation effects have resulted from long-term surface disturbance activities in the study area. Indirect effects from human presence, dispersal of noxious and invasive weeds, and dust effects from unpaved road traffic potentially have further reduced habitat quality and wildlife utilization in the study area. Collectively, it is conceivable that these effects have resulted in overall changes in habitat quality, habitat loss, increased animal displacement, reductions in local wildlife populations, and changes in species composition to some degree. However, as discussed above, the severity of these effects on terrestrial wildlife depend on factors such as sensitivity of the species, seasonal use, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, and climate).

Table ES.2.3-1 summarizes the existing development-related disturbance to vegetation communities as of the end of year 2003. Based on this GIS analysis, the existing development-related disturbance to associated wildlife habitats in the PRB study area totaled 121,890 acres, of which 51,107 acres of disturbance was related to coal mining activities (ENSR 2005b). The primary habitats impacted as a result of coal mine development have included mixed-grass and short-grass prairies and sagebrush shrublands. Lesser amounts of coniferous forest, riparian/wetland, and aquatic habitats also have been disturbed. Based on the Task 2 database, as of the end of 2003, approximately 136,284 acres of previously disturbed wildlife habitat had been reclaimed, inclusive of approximately 21,238 acres of habitat in previously mined areas (ENSR 2005a).

Big game species that occur in suitable habitats throughout the PRB study area include pronghorn, white-tailed deer, mule deer, elk (*Cervus elaphus*), and moose (*Alces alces*). The PRB study area includes crucial winter yearlong and severe winter range for pronghorn; crucial winter range, crucial winter yearlong range, and parturition areas for elk; and crucial winter yearlong and crucial yearlong areas for moose. No crucial or severe winter ranges have been identified within the PRB study area for white-tailed deer or mule deer. No big game migration corridors are recognized by the WGFD in this area.

Of the 13 pronghorn antelope heard units that are entirely or partially within the PRB study area, the overall population trend within 12 of the heard units has been stable to increasing. One herd unit exhibited a decreasing trend; this most likely is a result of bad winter weather causing high fawn mortality. Extensive on-going and planned future energy development are considered potential management concerns for some herd units. For example, increased road density, produced water

discharge, loss of vegetation, and increased human presence have had the potential to adversely affect herd units subject to CBNG development.

White-tailed deer population trends have been stable or increasing within the PRB study area. Increasing population levels can be accredited to the inaccessibility of habitat in the northwestern part of the PRB study area, which primarily consists of private land tracts.

For mule deer in the PRB study area, two out of the seven herd units in the PRB study area are exceeding population goals; the remaining five herd units are below their goal. Overall, the mule deer population trend is relatively stable to decreasing. Among those units that were below their goal, poor weather conditions, high fawn mortality, and lack of reliable population estimates are most likely responsible. Specific impacts on mule deer populations are unknown; however, it is assumed that increased road density, produced water discharge, loss of vegetation, and heightened human presence may cause stress to the herd units in areas that are subject to considerable development.

Elk in the PRB study area are exhibiting a stable to increasing population trend. However, some herd units have declined in response to management actions taken to decrease populations. Similar to mule deer, increased road density, produced water discharge, loss of vegetation, and increased human presence have the potential to negatively affect elk herds.

There is little suitable moose habitat within the PRB study area. Based on seasonal range maps from the WGFD, moose primarily are restricted to areas along the study area's western boundary in the Big Horn Mountains. There currently are no existing disturbances to moose habitat associated with energy development, agriculture, or urban development within the study area.

There are several raptor species that have the potential to occur within the PRB study area. These include: northern harrier, golden eagle, red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk, ferruginous hawk, American kestrel (*Falco sparverius*), prairie falcon, short-eared owl, and great horned owl (*Bubo virginianus*). Both the bald eagle and rough-legged hawk (*Buteo lagopus*) are common winter residents in the study area. Less common raptors in the study area include: osprey, merlin, and burrowing owl (*Athene cunicularia*). Habitat is relatively limited for raptor species that nest exclusively in trees or on cliffs. Some nests have been removed by mining activities, and it has been necessary to relocate others to avoid destruction. As mitigation, new nests have been created to replace some of the nests that have been removed. It is estimated that the PRB study area yields 2,690 to 4,410 active nests annually, with a total count of 12,360 nests (active and inactive).

Several species of upland game birds may occur within the PRB study area, including ring-necked pheasant (*Phasianus colchicus*), gray partridge (*Perdix perdix*), wild turkey (*Meleagris gallopavo*), mourning dove (*Zenaida macroura*), greater sage-grouse (*Centrocercus urophasianus*), and sharp-tailed grouse (*Tympanuchus phasianellus*) (Luce et al. 1999). The greater sage-grouse is discussed under Special Status Species. Mourning doves are abundant in a variety of habitats that occur in the study area. Both the gray partridge and ring-necked pheasant occur locally near agricultural lands and along river bottomland. Wild turkeys occur locally in ponderosa pine and shrubby or forested riparian areas. None of these species, with the exception of the greater sage-grouse, is specifically monitored or managed other than through normal hunting seasons.

Suitable waterfowl habitats within the PRB study area include major rivers, streams, creeks, draws, lakes, and ponds. There is no existing information on the specific impacts of existing oil and gas development on waterfowl. Existing impacts that may have occurred also are related to the various methods of CBNG water handling. At present, much of the CBNG produced water is discharged to surface drainages. Although much of this water evaporates or infiltrates, substantial quantities remain on the surface and have resulted in the expansion of wetlands, stock ponds, and reservoirs, potentially increasing waterfowl breeding and foraging habitats. Produced water in some parts of the study area is disposed of in containment reservoirs, which also may provide waterfowl habitats, although in many cases appropriate vegetative cover and foraging areas have not developed around these reservoirs. It is possible for salts to accumulate in some CBNG water containment reservoirs. As water evaporates, salinity increases and may result in mass production of salt tolerant invertebrates such as brine shrimp, a major food source attractive to birds (Pennak 1989; Tribbey 1988). Waterfowl mortalities resulting from salt crystallization and/or toxicity have been documented in hypersaline wetlands in North Dakota and California, where sodium concentrations exceeding 17,000 mg/L were reported and alternative freshwater sources were not available nearby (Gordus et al. 2002; Windingstad et al. 1987). Similarly, in Canada, lake concentrations of sodium in excess of 30,900 mg/L were reported to cause mortality in some Canada geese. Moving salt-stressed geese to freshwater resulted in full recovery (Wobeser and Howard 1987).

The median sodium concentration of Fort Union Formation CBNG produced water is 270 mg/L (BLM 2003a). If sodium concentrations are maintained below 17,000 mg/L in the evaporation ponds, the potential for adverse effects to waterfowl would be minimal. Further, presence of freshwater sources within the study area, including the Upper Tongue River; Upper, Middle, and Little Powder Rivers; and Crazy Woman Creek, would decrease the potential for sodium toxicity to migratory waterfowl (Kantrud and Stewart 1977; Swanson et al. 1983).

A wide variety of neotropical migrants use the PRB study area during migration or the breeding season. Few data are available on population numbers of these species; however, Breeding Bird Survey data can be used to determine population trends in a geographic area. Much of the recent energy development is too recent to have had a measurable effect on populations of migratory birds. Loss and degradation of habitats likely has occurred, as has disturbance-related effects to individual birds resulting from construction and production activities. In areas of concentrated development, the breeding density of some species may have been reduced due to these and other effects. Species that are specific to grassland and shrub-steppe habitats, and that are sensitive to disturbance and habitat fragmentation, likely have been the most affected.

Special Status Species

The PRB study area for special status species and related habitat values includes all or portions of Sheridan, Johnson, Campbell, and Converse counties including BLM- and USFS-administered lands and state and private lands.

Impacts to special status species have paralleled those discussed above for wildlife. A total of 2 federally listed species, 22 BLM sensitive species, 29 USFS sensitive species, and 24 WGFD native sensitive species were identified as potentially occurring in the PRB study area.

Federally Listed and Federal Candidate Species. No black-footed ferrets (federally endangered) currently are known to occur outside of reintroduced populations in Montana, South Dakota, Utah,

Arizona, and Carbon County in Wyoming. Consequently, no known populations of black-footed ferrets have been identified within the PRB study area.

The bald eagle (federally threatened) is a documented breeder and winter resident of suitable habitats within the PRB study area. Twelve active nests are known from within the study area, with seven nests within the Buffalo Field Office area and one within the Casper Field Office area. The remaining four nests are on non-BLM-administered land. WGFD also has identified numerous winter roosts in the study area.

The Preble's meadow jumping mouse (federally threatened) has been documented in two counties in Wyoming: along Crow Creek on the F.E. Warren Air Force Base (Laramie County), and in the Lodgepole Creek drainage within the Medicine Bow National Forest (Albany County). No known populations of Preble's meadow jumping mouse have been identified within the PRB study area.

The boreal toad (federal candidate) occurs in two distinct populations in Wyoming. The northern population, not listed as a federal candidate species, ranges from mid to higher elevations in Yellowstone and Grand Teton national parks and the Bridger-Teton, western Shoshone, and Targhee national forests. The southern population is restricted to a few isolated areas of the Medicine Bow National Forest. Current distributions of the Medicine Bow population are not known north of Carbon County. As a result, this species is not expected to occur within the PRB study area.

U.S. Forest Service Sensitive Species. The tiger salamander, Northern leopard frog, milk snake, American bittern, osprey, ferruginous hawk, merlin, long-billed curlew, upland sandpiper, mountain plover, black tern, western yellow-billed cuckoo, western burrowing owl, Lewis' woodpecker, loggerhead shrike, pygmy nuthatch, Baird's sparrow, fox sparrow, fringed-tailed myotis, Townsend's big-eared bat, black-tailed prairie dog, and swift fox are expected to occur in suitable habitats throughout the PRB study area.

The common loon and white-faced ibis are not expected to nest in the PRB study area, but may be observed in suitable habitats during migration. The greater sandhill crane is an uncommon breeding resident and migrant.

The Black Hills redbelly snake, flammulated owl, olive-sided flycatcher, and purple martin are not expected to occur within the PRB study area.

Wyoming BLM Sensitive Species. The spotted frog, trumpeter swan, northern goshawk, greater sage-grouse, sage thrasher, Brewer's sparrow, sage sparrow, and long-eared myotis are expected to occur in suitable habitats throughout the PRB study area.

The greater sage-grouse is highly dependent on sagebrush communities. Based on GIS data (BLM 2003a; Christiansen 2005), there are 385 lek sites in the study area. Although the range of this species is relatively unchanged, the population numbers have been trending downward in recent years. This decrease has been associated with the disturbance and destruction of suitable grouse habitats.

The peregrine falcon is not expected to nest in the PRB study area, but may be observed in suitable habitats during migration.

The spotted bat and white-tailed prairie dog are not expected to occur within the PRB study area.

See the USFS sensitive species subsection relative to the northern leopard frog, white-faced ibis, ferruginous hawk, long-billed curlew, western yellow-billed cuckoo, western burrowing owl, loggerhead shrike, Baird's sparrow, mountain plover, Townsend's big-eared bat, black-tailed prairie dog, and swift fox.

Wyoming Game and Fish Department Sensitive Species. The long-legged myotis, little brown myotis, big brown bat, and western small-footed myotis are expected to occur in suitable habitats throughout the PRB study area.

The American white pelican, black-crowned night heron, and snowy egret are not expected to nest in the PRB study area, but may be observed in suitable habitats during migration.

ES.2.4.2 Fisheries

General Fisheries

The project study area for fisheries consists of perennial streams and standing water environments (ponds, lakes, and reservoirs) within 18 fourth order watersheds (subwatersheds). The subwatersheds are part of eight basins: Powder River, Little Powder River, Tongue River, Cheyenne River, Belle Fourche River, North Platte River, Cheyenne River, Little Bighorn River, and Little Missouri River. Fish resources within the project area water bodies include a mixture of coldwater and warmwater species. Species that are managed by the WGFD include game or sport fish and special status species. Seventeen game fish species representing four families (trout, perches, catfishes, and sunfishes/bass) occur in one or more of the project area subwatersheds.

The Powder River and its tributaries support 28 known fish species of which 20 are native. Most of these species are tolerant of widely fluctuating environmental conditions, such as turbidity, salinity, and water temperature. The common species in the river include flathead chub, sturgeon chub, goldeye, river carpsucker, stonecat, common carp, longnose dace, and channel catfish. The game species in the Powder River and its tributaries include black bullhead, channel catfish, stonecat, smallmouth bass, rock bass, green sunfish, sauger, and walleye. Trout species such as brook trout and brown trout are found in the headwaters of the South Fork Powder River, Middle Fork Powder River, North Fork Powder River, Upper Powder River, Crazy Woman Creek, Clear Creek, Willow Creek, and Sanchez Creek. Standing waters in the Powder River Basin mainly consist of relatively small (less than 10-acre) reservoirs and farm ponds. Various trout species, channel catfish, and largemouth bass are the primary stocked species. Since 1995, most of the stocking has been done by private landowners.

The Little Powder River drainage basin contains the entire Little Powder River subwatershed. Flowing water in this basin is restricted to three stream reaches, all of which are on private land. The Little Powder River and a short reach of the Dry Fork of the Little Powder River below its confluence with Moyer Springs Creek are perennial. The only coldwater habitat in the drainage is Moyer Springs Creek, a 0.5-mile reach of stream that contains a wild brook trout population. There is no perennial water in any of the other tributary streams in the drainage. Only one small standing lake, Weston Reservoir (Little Powder Reservoir) is suitable for game fish and is on accessible

public land. Warmwater game fish species that occur in stream segments with more persistent flow include brown bullhead, channel catfish, green sunfish, and largemouth bass. Fish numbers are limited due to the relatively small size of the stream segments and low water levels.

The water bodies in the Upper Tongue River consist of headwater tributary streams, mainstem portion of the Upper Tongue River, and privately owned ponds. Aquatic habitat quality varies throughout the subwatershed. Although coldwater habitat is provided in the headwater tributaries, an absence or scarcity of deep pools in some of the streams limits the development of larger fish. Irrigation diversions reduce flows on many streams and form barriers downstream of Interstate (I)-90 that impede seasonal upstream fish movements. Game fish species include the Snake River cutthroat trout and Yellowstone cutthroat trout and rainbow, brown, and brook trout, which inhabit headwater tributaries. The lower portion of the Upper Tongue River also supports sauger and smallmouth bass. Some of the ponds contain warmwater game species such as brown bullhead, channel catfish, green sunfish, white crappie, and rock bass.

Most of the streams in the Upper Belle Fourche River subwatershed are unsuitable for coldwater fish due to higher water temperatures. None of the streams located in the Upper Belle Fourche subwatershed support self-sustaining trout populations. Habitat for warmwater fish also is limited as a result of water diversions and the relatively small size of the water bodies. Private farm ponds and reservoirs represent the primary type of warmwater habitat. Limited information is available for fish occurrence in the privately-owned water bodies. Game fish species likely inhabiting many of the ponds and reservoirs include black bullhead and green sunfish. The Belle Fourche River below Keyhole Reservoir is dominated by native nongame fish species but also contains game species such as channel catfish and smallmouth bass.

Subwatersheds in the Cheyenne River Basin include Antelope Creek, Upper Cheyenne River, Dry Fork Cheyenne River, and Lightening Creek. Approximately 45 percent of the basin is located on public land managed by the BLM, USFS, or the state. However, most of the bottomland and riparian areas of the Cheyenne River are privately owned. Streams in these subwatersheds are considered unsuitable habitat for game fish species by the WGFD as a result of intermittent flows and relatively high summer water temperatures. Standing waters in the basin consist of reservoirs and ponds, most of which are less than 10 surface acres. WGFD stocks privately owned farm ponds based on their potential to support game fish species and access to public fishing. Green sunfish and black bullhead are known to be abundant in some water bodies. Channel catfish and largemouth bass may be present in low numbers in some water bodies.

The Middle North Platte Casper subwatershed is contained within a small portion of this basin (northwest corner) and includes watercourses such as Sage Creek and Sand Creek. The area on the north side of the North Platte River is arid with typical plains streams. The streams within this basin generally are small, and flows are intermittent or low throughout the year. They flow through low-gradient sandy and silty soils that generally are not suitable habitat for game fish species.

Within the project study area, the Little Bighorn subwatershed contains a few perennial streams such as Elkhorn, Gay, East Pass, West Pass, Twin, and East Twin creeks. The Little Bighorn River basin is a tributary to the Yellowstone River and historical range for native Yellowstone cutthroat trout. Due to the remoteness of part of the drainage basin, especially the West Fork of the Little Bighorn River Basin, fishery surveys have been limited, and data are lacking to evaluate the presence of endemic populations of Yellowstone cutthroat trout. Various trout species occur in

Elkhorn, East Pass, West Pass, and East Twin creeks. Flow in Twin Creek, a tributary to East Pass Creek, is insufficient to support trout.

The majority of the drainage basin is contained within Crook County except for some very small sections in Campbell County. These small sections within Campbell County contain the Little Missouri River subwatershed within the study area. Small stock water ponds and irrigation reservoirs in the Hattie Creek, Switzer Draw, Cracker Creek, and Flat Creek drainages provide the majority of fisheries habitat. WGFD listed the majority of the water bodies in this drainage basin as unsuitable for sustaining a fishery.

Sufficient information is not available to make statements about trends in fish populations or aquatic habitat in the PRB study area. Stream segments on public-administered land exhibit varying habitat conditions that range from low to quality. Fish population numbers are not monitored or censused on a frequent basis.

Sensitive Fish Species

Eleven fish species that potentially occur in the project area subwatersheds have special status designations. No federally listed, proposed for listing, or candidate fish species occur in the project study area. However, 11 species have special status by the BLM, USFS, or WGFD. Yellowstone cutthroat trout is considered a sensitive species by the BLM, while the flathead chub and plains topminnow are considered USFS sensitive. All 11 species have one of the three highest priority designations (SSC1, SSC2, and SSC3) by the WGFD. The following information summarizes the occurrence and habitat used by these species within the PRB study area.

- Flathead chub – It is known to occur in the Powder River, Little Powder River, Tongue River, Cheyenne, Little Bighorn, and Little Missouri basins and 12 subwatersheds within the study area. Surveys conducted in 2002 collected this species in the mainstem portion of the Powder River and several tributary draws. The preferred habitat for this species is relatively large rivers and streams in areas with swift currents and sand or gravel substrates.

- Plains Topminnow – This species is known to occur in Sage Creek, a small tributary located in the upper Cheyenne River subwatershed. In Wyoming, the plains topminnow's characteristic habitat is clear, sand or gravel-bottomed streams with considerable vegetation. It often is collected in streams inhabited by plains killifish. Spawning occurs in late spring or early summer in habitat with aquatic macrophytes.

- Yellowstone Cutthroat Trout – This species may occur in suitable aquatic habitats of the Upper Tongue and Little Bighorn subwatersheds within the study area. Suitable habitats include coldwater rivers, creeks, beaver ponds, and large lakes.

- Goldeye – This species occurs in the Upper Powder River, Crazy Woman Creek, Clear Creek, and Middle Powder River subwatersheds in the Powder River Basin and the Little Powder River subwatershed. It occurs in lake and stream habitats and can tolerate turbid conditions.

- Lake Chub – The lake chub inhabits foothill streams and lakes in the Upper Tongue and Little Powder River, and Upper Belle Fourche River subwatersheds. Lake populations usually show movements in the spring to tributary streams where they utilize rocky substrates.

- Mountain Sucker – Six subwatersheds are inhabited by mountain sucker: Upper Tongue River, Middle Fork River, South Fork Powder River, Crazy Woman Creek, Middle Powder River, and Little Powder River. The mountain sucker utilizes a variety of habitats such as larger streams, rivers, lakes, and reservoirs with sand, gravel, or mud substrates. The species usually is associated with undercut banks, eddies, and pools with moderate current.

- Silvery Minnow – This species occurs in the Middle Powder River and Little Powder River subwatersheds where it prefers relatively large clear streams. This species often occurs in the same streams as flathead chub.

- Sturgeon Chub – Within the study area, the Upper Powder River is the only subwatershed inhabited by sturgeon chub, where it has been collected in the mainstem portion of the Powder River and several tributary draws. This species prefers swift currents in large, turbid rivers with sand or gravel-dominated bottoms.

- Plains Minnow – This species occurs in nine of the project area subwatersheds (Upper Tongue River, Upper Powder River, South Fork Powder River, Salt Creek, Clear Creek, Middle Powder River, Little Powder River, Upper Cheyenne River, and Upper Belle Fourche River). Plains minnow prefers slower-moving water and side-pools in turbid streams.

ES.2.5 Grazing

The study area for grazing includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. Livestock grazing is one of the primary land uses within the PRB study area since the majority of the area consists of rangeland, most of which is privately owned. Livestock grazing occurs on lands administered by the BLM, USFS, and State of Wyoming. BLM-administered rangeland within the study area is managed by the Buffalo Field Office (Sheridan, Johnson, and Campbell counties) and Casper Field Office (northern portion of Converse County). USFS-administered rangeland within the study area is part of the TBNG, which is managed by the Douglas Ranger District.

Table ES.2.5-1 summarizes livestock grazing on federal lands in the study area. Livestock grazing that occurs on BLM-administered rangeland in the Buffalo Field Office area includes 470 grazing allotments, which cover approximately 798,000 acres with an associated 398 lessees and 420 grazing leases. The majority of BLM grazing allotments that occur in the study area are leased by one lessee, although several allotments are leased by two or more lessees.

The majority of ranch operations consist of cow/calf pairs (approximately 90 percent) and yearlings, and the remainder consists of sheep operations. Authorized livestock use within these grazing allotments total 105,152 animal unit month (AUMs).

Livestock grazing that occurs on BLM-administered rangeland in the Casper Field Office area includes 50 grazing allotments, which cover approximately 73,000 acres with an associated 51 lessees and 51 grazing leases. All of the ranch operations consist of cow/calf pairs or sheep operations. Authorized livestock use within these grazing allotments total 27,623 AUMs.

Table ES.2.5-1
Rangeland Summary for Federal Lands in the Study Area

Allotments, Lessees, and AUMs	BLM-administered Rangeland	USFS-administered Rangeland	Total
Number of Grazing Allotments	520	75	595
Acres of Rangeland	871,000	266,000	1,137,000
Number of Lessees	449	48	497
Number of Grazing Lessees	471	74	545
AUMs	132,775	51,373	184,148

Sources: Medders 2004; Nelson 2004; Schmitt 2004; and Stanton 2004.

Livestock grazing that occurs on USFS-administered rangeland in the southern portion of the TBNG includes entire or partial portions of 60 grazing allotments, which cover approximately 174,000 acres with an associated 34 lessees and 60 grazing leases. The majority of USFS grazing allotments that occur in the study area are leased by one lessee, although several allotments are leased by two or more lessees (i.e., community allotments). The majority of ranch operations consist of cow/calf pairs and yearlings, and, to a lesser extent, sheep. Authorized livestock use on the grazing allotments total 37,573 AUMs.

Livestock grazing that occurs on USFS-administered rangeland in the northern portion of the TBNG (i.e., Spring Creek Unit north of Gillette, Wyoming) includes entire or partial portions of 15 grazing allotments, which cover approximately 92,000 acres with an associated 14 lessees and 14 grazing leases. The majority of USFS grazing allotments that occur in the study area are leased by one lessee, although several allotments are leased by two or more lessees (i.e., community allotments). The majority of ranch operations consist of cow/calf pairs (89 percent) and sheep (10 percent). Horses also utilize rangeland within this area but only comprise 1 percent of all grazing within the area. Authorized livestock use on the grazing allotments total 13,800 AUMs.

Based on GIS analysis, the existing surface disturbance associated with development activities in the study area (as of the end of 2003) has resulted in the loss of approximately 56,788 acres of rangeland, 36,265 acres of which occur on BLM-administered allotments and 20,523 acres of which occur on USFS-administered allotments. Approximately 1,912 acres of the existing disturbance on the BLM-administered allotments is related to coal mine development (ENSR 2005b). The majority of surface disturbance in the study area has occurred on private property. Based on an average stocking rate of 6.0 acres per AUM on BLM-administered allotments in the study area and an average stocking rate of 4.0 acres per AUM on USFS-administered allotments, past and present development has resulted in the loss of 6,044 and 5,130 AUMs, respectively.

ES.2.6 Cultural Resources and Native American Concerns

The study area for cultural resources includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS.

ES.2.6.1 Cultural Resources

The majority of data on cultural resources in the PRB study area is based on a file search conducted through the Wyoming Cultural Records Office database in late March 2001. The file search covered Campbell, Converse, Johnson, and Sheridan counties through the year 2000. The database of cultural resource survey reports, cultural resource sites, and isolated finds contained 8,120 sites and 2,831 isolated finds. At the time of the file search, approximately 10 percent of the study area had been inventoried at the Class III level for cultural resources. Inventory coverage was strongly concentrated in the eastern half of the study area. This concentration of coverage was a result of nearly all of the cultural resources work being done in relation to coal development.

Currently, the Wyoming State Historic Preservation Officer (SHPO) is preparing a regional database of all recorded cultural resources located in the PRB. The database includes, but is not limited to, the number of sites and their location, site types, recordation date, report author, and each site's National Register of Historic Places (NRHP) eligibility status. Information obtained from the database indicates that a total of 1,339,122 acres (17 percent) of the study area has been inventoried to Class III standards. Similar to the file search results, inventories are concentrated in the eastern half of the study area as a result of cultural work conducted for coal development.

According to the SHPO database, 10,795 cultural sites have been identified in the study area. Of these, 5,871 (54 percent) are prehistoric sites, 2,664 (25 percent) are historic sites, 167 (1.6 percent) are multi-component sites, 51 (less than 1 percent) are sites of unknown cultural affiliation, unknown use, or with no information, and 2,042 (19.0 percent) sites are labeled as "not encoded." The SHPO defines "not encoded" as those sites that have no field value entered in the database.

Prehistoric Sites

All recognized prehistoric cultural periods, from Clovis through Protohistoric (about 11,500 to 200 years ago), are represented in the study area. The earliest prehistoric cultural periods, Paleoindian through Early Plains Archaic, are represented by only a small number of sites. Archaic and later prehistoric period sites (Archaic to Protohistoric) are represented in increasing numbers as a result of higher populations through time and better preservation of more recent sites.

Artifact scatters, camps, habitation features, rock features, and lithic sources are the predominate prehistoric site type in the study area. Prehistoric site densities vary from extremely high in some settings, such as certain ridgetops and areas near larger, more reliable drainages, to nonexistent in other settings. The factors affecting these differences in density are not always readily apparent. If a location is used by a large number of people or repeatedly over a long period, lost or discarded cultural materials would accumulate. If the landform remains stable over time and is not degraded, deeply buried, or mechanically disturbed, the site would remain visible. Site density is influenced by the size and number of groups that used the area and the availability or density of resources. High site densities often are associated with locations that have a predictable abundance of particular resources, locations that have a moderate abundance of several distinct resources, or locations that have access to several resource areas. Another factor that is frequently noted in site location is proximity to a reliable source of water. Other factors may be responses to seasonal conditions, such

as winter camps with minimal snow accumulation that are sheltered from the wind, or summer camps on higher benches away from swarming bugs.

Historic Sites

Historic site categories documented for the study area are based on broad historic themes. The site categories are Rural, Urban, Mining, Transportation, Military, Exploration, and Communication. Rural/agrarian sites dominate known historic sites because that is where the majority of systematic surveys have been conducted. These include homesteads, farms, ranches, agrarian and ranching features, irrigation features, and rural residences. The principal exception is the Upper Tongue River subwatershed, in which a large number of urban buildings and structures have been documented in Sheridan. The next most common site type is transportation features, which include trails, roads, bridges, railroads, stage stations, railroad stations, and related structures or features. Where historic military sites, early exploration sites, and early transportation sites have been recognized and documented, most are considered significant because of their associations with significant historic events. The Bozeman Trail, its several variants, and related sites, were highly significant in western history and retain a large number of well preserved segments. The Outlaw Cave/Red Wall area of the Middle Fork Powder River is rich in prehistoric caves and rockshelters, premiere prehistoric rock art sites, prehistoric stone features, and historic sites that figure prominently in Western lore.

ES.2.6.2 Native American Concerns

The 1992 National Historic Preservation Act (NHPA) amendments place major emphasis on the role of Native American groups in the Section 106 review process. Subsequent revisions to the regulations of the Advisory Council on Historic Preservation (Council) published May 18, 1999, incorporate specific provisions for federal agencies to involve Native American groups in land or resource management decisions and for consulting with these groups throughout the process. Before making decisions or approving actions that could result in changes in land use, physical changes to lands or resources, changes in access, or alienation of lands, federal managers must determine whether Native American interests would be affected, observe pertinent consultation requirements, and document how this was done. The consultation record will be the federal agency's basis for demonstrating that the responsible manager has made a reasonable and good faith effort to obtain and consider appropriate Native American input in decision making.

Under Native American Consultation:

- The federal agency must consult with any Native American group that attaches religious and cultural significance to historic properties that may be affected by an undertaking regardless of location (Section 101[d][6][b]). Such Native American group is a consulting party.

- The federal agency must make a reasonable and good faith effort to identify Native American groups to be consulted.

- The federal agency must be respectful of tribal sovereignty in conducting consultation.

- The federal agency must recognize the government-to-government relationship.

- Historic properties of religious and cultural significance may be located on ancestral, aboriginal, or ceded lands of Native Americans.

- The Native American groups may enter into agreement with the federal agency regarding any aspect of tribal participation in the Section 106 review process. The agreement may provide the Native American groups with additional participation or concurrence in agency decisions under Section 106 provided that no modification may be made in the roles of other parties without their consent.

As a formal participant in the national historic preservation program, a tribe may assume official responsibility for a number of functions aimed at the preservation of significant historic properties. Those functions include identifying and maintaining inventories of culturally significant properties, nominating properties to national and tribal registers of historic places, conducting Section 106 reviews of federal agency projects on tribal lands, and conducting educational programs on the importance of preserving historic properties.

When an undertaking occurs on or affects historic properties on tribal lands, federal agencies must consult with a representative designated by the tribe, the Tribal Historic Preservation Officer (THPO). In some cases, the THPOs have formally assumed the responsibilities of the SHPO on their tribal lands. Whether or not the THPO has formally assumed SHPO responsibilities, they must be consulted when an undertaking occurs on tribal lands.

While the THPO must be consulted when a project occurs or affects historic properties on tribal lands, many historic properties of religious and cultural significance to Indian tribes are not located on tribal lands. Section 101(d)(6) of the NHPA states that properties of traditional religious and cultural importance to tribes can be eligible to the NRHP. This section goes on to require that agencies consult with any Indian tribe that attaches religious and cultural importance to such properties. This consultation requirement applies regardless of whether such properties are on or off tribal lands.

In accordance with Section 106 of the NHPA and the Native American Graves Protection and Repatriation Act (NAGPRA), Native American consultation would be conducted as part of National Environmental Policy Act (NEPA) compliance for future federally permitted projects.

ES.2.7 Land Use and Recreation

The study area for land use issues includes all or most of Campbell, Converse, Johnson and Sheridan counties. A somewhat larger perimeter around this primary study area was considered for wilderness issues.

ES.2.7.1 Land Use, Access, and Easements

The PRB study area is a predominantly rural, wide open landscape. A substantial majority (77.8 percent) of the surface ownership in the study area is privately owned. Approximately 14.2 percent is federal with the BLM managing 11.0 percent and the USFS overseeing 3.2 percent. The State of Wyoming owns approximately 7.9 percent of the study area, mostly state trust lands.

In contrast to the surface ownership, mineral rights in much of the study area are in "split-estates." In much of the study area, the surface is privately owned but the mineral rights are at least partly federally owned. Although the federal government owns all mineral rights on large portions of the study area, there also are sizable areas where it owns only the coal rights and somewhat smaller areas where it owns only oil and gas rights. The State of Wyoming typically owns the mineral rights for a majority of the state trust lands.

Climate and soil conditions in the study area dictate that the predominant use of land is for grazing; nevertheless, there is a range of other uses in the area. The major categories include agriculture, forested, mixed rangeland, urban, water, wetlands, coal mines, and barren land. **Table ES.2.7-1** shows approximate acreages for each of the land uses.

Table ES.2.7-1
Land Use by Surface Ownership
(acres)

Use Category	BLM	USFS	State	Private	Total	
					Acres	Percent
Agriculture	2,627	14,197	13,770	472,811	503,405	6.3
Barren	165	205	187	9,396	9,953	0.1
Forested	137,555	14,604	48,645	332,062	532,866	6.7
Mixed Rangeland	732,014	218,156	561,363	5,271,644	6,783,177	86.0
Urban	893	17	1,039	25,469	27,418	0.3
Water	35	73	334	4,773	5,215	<0.1
Wetlands	0	104	559	1,566	2,229	<0.1
Coal Mines	149	7,236	2,805	40,917	51,107	0.6
Total	**873,438**	**254,592**	**628,702**	**6,158,638**	**7,915,370**	**100.0**

Note: Based on land use categories in the land use GIS file, which differ in areal extent from the categories in the vegetation GIS file.

Source: ENSR 2005b.

Agricultural land uses in the study area include cropland and pasture, confined feeding operations, and other agricultural uses. Most of the cropland is not irrigated. Rangeland is primarily used for livestock grazing, which is the dominant land use in the study area on private and public lands. Urban land uses in the study area are mostly located in or immediately adjacent to incorporated communities. There are several large to very large coal mines in the study area. There also are existing and historic mines in the study area that have produced coal, uranium, bentonite, and aggregate materials (sand and gravel).

As of the end of 2003, approximately 14,785 CBNG wells and 6,846 conventional oil and gas wells existed on federal, state, and private lands within the study area. The wells and ancillary facilities have resulted in approximately 40,042 acres of disturbance to existing land uses (ENSR 2005a).

Land Use Planning and Management

Lands administered by the BLM in the study area are managed under the guidance of adopted Resource Management Plans (RMPs) for the Buffalo and Casper field offices. Several BLM Special Management Areas (SMAs) that provide recreational opportunities are located within the study area. These areas include wilderness study areas (WSAs) and other special areas. Oil and gas leases prohibit surface occupancy in WSAs in order to preserve wilderness values. Surface disturbances also are restricted within Recreational Areas (RAs) and Wildlife Habitat Management Areas.

Most of the BLM and USFS lands in the study area are used for livestock grazing under permitted grazing allotments, which are classified based on productivity.

The USFS administers land use on National Forest System lands based on multiple use principles. The TBNG, makes up the bulk of USFS-administered land in the study area. Guidance is provided by the Land and Resource Management Plan (LRMP) for the Medicine Bow National Forest and TBNG (USFS 2001a, 2001b, 2002). Most of the USFS-administered land in the study area is managed for livestock grazing.

Wyoming established the State Land Use Commission in 1975 to guide land use planning in the state. The Office of State Lands and Investments is responsible for all leases, easements, and temporary uses on state lands, including mineral and agricultural leasing, timber leasing and sales, and public recreation. The WOGCC regulates drilling and well spacing, regardless of land ownership, including wells on federal lands.

The City of Gillette and the Town of Wright have zoning ordinances and land use plans for the incorporated areas. The City of Gillette/Campbell County Comprehensive Planning Program addresses potential future land use. The Converse County Land Use Plan describes the current land use in the study area as primarily agriculture and dryland grazing. Mineral extraction, the second most prominent use, is exempted from local regulations by state law. Johnson County promulgated a Draft Comprehensive Land Use Plan in June 2004. The communities of Buffalo and Kaycee have land use plans for their urban areas. The Sheridan County Zoning Resolution and Growth Management Plan (Sheridan County 2001a,b) guide development in unincorporated areas of the county. Zoning for most of the county is agricultural.

ES.2.7.2 Recreation

With nearly 80 percent of the PRB study area privately owned, the public lands provide important open space and recreation resources including both developed recreation facilities and areas to pursue dispersed recreation activities. The private sector contributes commercial recreation opportunities and tourism services such as motels and restaurants. Some private landowners also allow hunting with specific permission, often for a fee.

Major attractions include the TBNG, several state historic sites, and the historic Bozeman Trail. Formal recreation opportunities are most prevalent in the western portion of the study area, near the foothills of the Big Horn Mountains and in the Powder River Breaks.

The primary developed recreational sites on BLM lands, all in the Buffalo Field Office area, include the South Big Horns Area, in southwest Johnson County; the Middle Fork Recreation Area (RA), along the Middle Fork of the Powder River; and the Dry Creek Petrified Tree Environmental Education Area, near Buffalo. The Mosier Gulch RA, west of Buffalo, and the Weston Hills RA, in the eastern part of the study area, provide additional recreational opportunities. Historic sites associated with the Bozeman Trail provide recreational opportunities through interpretive programs.

The TBNG provides a variety of recreational opportunities to local residents and visitors on USFS-administered land.

Dispersed recreational opportunities in the study area include hunting, fishing, sightseeing, off-road vehicle (ORV) use, and camping. Hunting is a major recreation use of federal and state lands in the study area; various big game and upland game bird species are hunted in the region. Mule deer and pronghorn hunting are by far the most popular hunting activities in the study area, accounting for 35,529 and 21,304 hunter days, respectively, in 2003 (Stratham 2005). The next highest were cottontail rabbit (2,348 hunter days) and elk (2,055 hunter days), followed by wild turkey (1,019), sharp-tailed grouse (508), and sage grouse (38). Consistent trends in hunter activity over the past decade are not discernible from the WDFG data. All of the most prominent species hunted in the study area have had high years and low years; pronghorn hunting, for example, was greatest from 1993 to 1996, while elk hunting was at its peak in 2001 and 2002. Mule deer hunting has been the most consistent ranging from a low of 28,311 hunter days in 1996 to a high of 37,307 hunter days in 2002.

Recreational use of public lands in the study area has increased substantially over the past two decades, and is expected to continue to increase by about 5 percent every 5 years for most recreational activities (BLM 2001a). ORV use in the study area is allowed on most BLM lands. Nearly all of the TBNG also is available for ORV use. Some private landowners in the study area receive supplemental income from providing public access for hunting and fishing.

There has been a trend toward a reduction in private land available for public hunting in recent years (Shorma 2005). WDFG attributes much of the change to the expansion in CBNG development in the PRB (Shorma 2005; Jahnke 2005). Several factors may be involved including the spacing of CBNG wells and the associated network of roads and support facilities that create both real and perceived safety problems, especially for rifle hunters; mineral royalties and surface reclamation reimbursements reduce a landowner's need for revenue from hunting; and the activity levels associated with CBNG development may displace wildlife from their traditional ranges (Shorma 2005). Coal development is not considered to be a major factor in the reduced hunting access, because it is much more localized with disturbed acreage concentrated in a few areas (Jahnke 2005). Reclaimed mine lands may or may not be available for hunting and other recreational activities depending on site-specific constraints.

CBNG development has had the effect of degrading the hunting experience for those who do hunt in the PRB, resulting in a substantial number of adverse comments in the WDFG's hunter harvest surveys (Jahnke 2005). The loss of hunting land also has created problems for the WDFG, making herd management more difficult and reducing revenues from hunting (Shorma 2005). The reduced access to private land has substantially increased pressure on public lands and has tended to concentrate hunting activity (Jahnke 2005).

Recreation Planning

The goals of recreation management for all BLM-administered lands in the study area are to provide outdoor recreational opportunities while also protecting resources, providing visitor services, and protecting the health and safety of public land visitors. Details on recreation objectives and standards for BLM lands in the study area can be found in the Buffalo and Casper Field Office RMPs (BLM 1997b, 2001b).

The Medicine Bow-Routt National Forest LRMP addresses recreation in the TBNG (USFS 2001a). National Forest System lands are inventoried and mapped by Recreation Opportunity Spectrum class to identify the opportunities for recreation activities.

The Wyoming Department of State Parks & Cultural Resources has promulgated rules and regulations governing state parks. There is no provision in the rules and regulations governing the development of mineral or other industrial developments within state parks.

Land use plans of the four counties in the study area all address recreation activities and facilities to varying degrees. All consider recreation as an important community asset.

ES.2.7.3 Wilderness and Roadless Areas/ Wild and Scenic Rivers

There are no designated wilderness areas in the PRB study area. There are three BLM WSAs in the study area: the Fortification Creek WSA, the North Fork WSA, and the Gardner Mountain WSA. The WSAs await Congressional action before they can be designated or released from consideration.

There is a USFS “inventoried roadless” area within the TBNG. It was not recommended for wilderness designation but, as with the WSAs, it will not be released from consideration until, and unless, Congress acts on it.

The BLM has identified public lands along four waterway segments in the study area that were determined to meet the eligibility criteria for Wild and Scenic River (WSR) designation. Of the four, only the Middle Fork of the Powder River was determined to be ”suitable” for addition to the WSR System.

ES.2.8 Noise and Visual Resources

The study area for noise and visual resource issues primarily is focused on Campbell, Converse, Johnson and Sheridan counties.

ES.2.8.1 Noise

Ambient noise is generally a function of land use and density, although other environmental factors also often play a significant role. Wind, precipitation, wildlife, and insects substantially can increase ambient noise.

Land uses in the PRB study area range from sparsely populated rural ranching areas to more densely populated urbanized areas and industrial areas including coal mining and oil and gas operations. Major sources of noise are larger towns; industrial facilities, such as coal mines and gas compressor stations; and major transportation facilities, particularly higher volume roadways (I-90, I-25, and State Route [SR] 59) and railroad corridors. Frequent high winds raise noise levels well above the ambient levels observed when it is not windy.

Background noise measurements have not been conducted in the study area; however, noise in rural areas away from industrial facilities and transportation corridors is likely to be in the range of 30 to 40 decibels on the A-weighted scale (dBA) when the wind speeds are low. Levels of noise close to industrial facilities and transportation corridors are likely to be in the range of 50 to 70 dBA or more, depending on the source and proximity to the source. The greatest noise from CBNG operations results from operation of multi-engine compressor stations moving gas from gathering facilities to high-pressure transmission pipelines. Noise from compressor stations has been estimated at 55 dBA at 600 feet from the compressor station (BLM 2000b).

The potential effects of noise depend on the spatial relationship between a noise source and noise-sensitive receptors. Noise attenuates over distance; the rate of attenuation also depends on the ground surface, atmospheric conditions, and topography, which either can block or reflect noise transmission. Consequently, effects of noise are site-specific and generalizations over an area as large and diverse as the study area may be misleading if not carefully qualified.

ES.2.8.2 Visual Resources

The PRB study area is in the Great Plains physiographic province; it is bordered by the Big Horn Mountains to the west and the Black Hills to the east. The landscape is composed of open grasslands, low rolling hills, and unobstructed views over many miles in most places. Most of the area is covered with dryland vegetation consisting of grasses and shrubs. Large portions of the northeast quarter of the study area are ponderosa pine forest. Outside the urban centers of Sheridan, Gillette, Buffalo, and Douglas, the study area is characterized by a rural landscape that has been modified by oil and gas field development, coal mines, grazing, and small towns. Portions of the study area remain natural and undeveloped in character despite widespread mineral development and grazing.

Most of the higher quality scenery is found in the western part of the study area. The South Big Horns Area along the Middle Fork of the Powder River has unique scenic resource values. The Powder River Breaks in eastern Johnson County, the Fortification Creek SMA and WSA, and the Weston Hills RA in the eastern part of the study area also provide higher quality scenic settings.

Oil and gas pumping units and associated well pads and access roads are evident in much of the study area. Well development is most evident in Campbell County between Gillette and Wright, and north and west of Gillette. The wells are readily visible and visually dominant in foreground views from roads and trails. At greater distances, oil and gas facilities are less visually prominent; exposed soils of well pads and associated access road clearings are the most obvious features.

The most prominent natural gas features are the large compressor stations. Although colors are usually selected to blend with the surroundings, the scale and character of the structures typically is

larger and appears more industrial than the agricultural landscape and facilities common to the area. Oil development generally entails the use of pumping “mules” on oil wells and tanks to store the oil awaiting shipment. Though typically smaller than the compressor stations, these facilities are more widely dispersed in the landscape and sometimes exhibit greater color contrast.

Coal mining occurs primarily in the east-central part of the study area, east and south of Gillette. Twelve open-pit coal mines are actively producing coal in Campbell County; one coal mine in Campbell County is temporarily inactive. Open-pit mining results in landscapes that have been altered considerably from their natural character while mines are active. Landscape disturbance from coal mines persists until reclamation has been accomplished.

The BLM is responsible for identifying and protecting scenic values on public lands under several provisions of the Federal Land Protection and Management Act and NEPA. The BLM Visual Resource Management (VRM) system was developed for that purpose. The VRM system includes an inventory process, and a "contrast rating" procedure for evaluating the potential visual effects of a proposed project or management activity.

Four VRM classes have been identified in the study area. Class IV lands encompass 77.8 percent of the study area, Class III 13.7 percent, and Class II applies to 7.2 percent of the area. Class V, Rehabilitation, applies to active coal mines and to certain areas near the larger communities in the study area. Class V is applied to 1.4 percent of the study area.

The Medicine Bow-Routt National Forest inventoried visual resources under the new Scenery Management System, which parallels the BLM VRM system with some variations in application and terminology. Scenic Integrity Objectives (SIO) were assigned to each management area based on the applicable goals for the area. TBNG lands in the study area have been inventoried with two of the possible five SIOs: Low, where the landscape character appears moderately altered by development, and Moderate, where the valued landscape character appears slightly altered.

Three of the four counties in the study area consider the importance of scenic resources through their land use planning policies; Converse County does not.

Most of the study area is not considered visually sensitive because of its remoteness from viewpoints used by the public. Portions of the area that have relatively higher levels of sensitivity to landscape modification occur near communities, along highway corridors, and at recreation-use areas.

ES.2.9 Transportation and Utilities

The study area for transportation and utilities includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area.

ES.2.9.1 Transportation

In keeping with the low density of population in the study area, the major road network is quite sparse. In the approximately 120-mile by 140-mile study area, there are only two major north-south highways, I-25 and SR 59, and one major east-west route, I-90. Two additional primary highways, U.S. Highway 14-16 and SR 387, cross the study area from east to west. Several short segments of U.S. highways and secondary state roads and numerous county roads also provide local access to public and private lands in the study area. In addition, there is a complex network of essentially unimproved and only minimally maintained backcountry roads serving the area, some of which are not open to public access without landowner permission.

Traffic volumes on the road network in the study area are highly variable. The highest volume counts are found on major roadways in or near the largest communities. In rural areas, I-90 and I-25 carry by far the largest traffic loads. Current traffic loads are well within the capacity of major highways in the study area. The only discernible pattern of change in traffic volumes over the past 5 years is a relatively large increase in traffic in or near the larger communities. Rates of change in traffic volumes elsewhere in the study area have varied greatly from moderate decreases to sizeable increases. The percent changes in traffic volumes were larger from 1998 to 2003 than from 1994 to 1998, primarily in the Gillette and Sheridan areas. This change in traffic growth rates tracks with the increased population growth rates in Campbell and Sheridan counties in the latter half of the past decade, which have been driven by increases in coal and CBNG employment.

BLM transportation planning for the study area is discussed in the updated RMPs, for the Buffalo and Casper field offices (BLM 1997b; 2001b). New roads across non-federal lands would have to comply with requirements of the state or local jurisdictions, mainly counties. The four counties in the study area have given varying degrees of attention to planning for transportation improvements. Campbell and Converse counties have transportation elements in their comprehensive plans; Johnson and Sheridan counties do not have formal transportation plans. Many of the existing roads within the study area need repairs or improvement. Planned major improvements are addressed in the Wyoming Department of Transportation (WYDOT) 2005 Surface Transportation Improvement Program (WYDOT 2004).

One major railroad, the Burlington Northern/Santa Fe Railroad (BNSF), enters the study area from Montana north of Sheridan, runs southerly through the city, and then southeast through Gillette to South Dakota. A joint BNSF and Union Pacific route, primarily serving coal trains from PRB mines, heads south from Gillette toward Douglas where it splits into southerly and easterly branches. There is a major marshalling yard and repair facility about 5 miles south of Bill. Several spur lines connect directly to mines in the area.

Current coal train traffic averages approximately 144 coal unit trains (loaded and empty) per day, 110 on the southern route and 34 on the northern route (Bartlett 2004; Roark 2004). The number of trains is very close to the number predicted for 1995 in the Powder River FEIS Coal (BLM 1981). The volume of coal shipped is greater than predicted, however, because trains today range from 118 to 135 100-ton cars, rather than the 100 100-ton cars predicted in 1981. Over 75 percent of the coal trains currently head south out of the PRB, compared to a nearly even north-south split predicted earlier. The difference has been accommodated by upgrading the line south of Bill, Wyoming to a triple track configuration.

Three public airports exist in the study area (AirNav.com 2001); the Gillette-Campbell County Airport northwest of Gillette, Sheridan County Airport southwest of Sheridan, and Johnson County Airport northwest of Buffalo. Federal Aviation Administration regulations require a 2-mile radius safety zone around airports and restrict height of construction within 5 miles to reduce the potential for safety hazards near airports.

ES.2.9.2 Utilities

There are two major electric power line corridors through the study area, both running in a generally north-south direction, both containing 230-kilovolt power lines. The westerly corridor parallels the I-90 corridor from the Montana border to Buffalo, then follows the I-25 corridor through Casper, Douglas, and south to Wheatland. The second major corridor runs along the east side of the study area from the 500-megawatt (MW) Wyodak/Neil Simpson/Wygen Power Plant complex near Gillette to the 750-MW Dave Johnston Power Plant near Glenrock.

The PRB study area is crossed by an extensive network of oil and gas pipelines due to its history of oil and natural gas production. Among the major crude oil lines are the 18-inch Belle Fourche pipeline running northeast from a junction near Kaycee to the Montana state line near the Campbell – Crook County line, and the 18-inch Rocky Mountain Pipeline System line running south to Casper from the same junction northeast of Kaycee.

The gas collection network is expanding as new areas are being developed for CBNG production. There are numerous large diameter natural gas pipelines carrying gas from the gathering lines to markets outside the basin, mainly to the south. There are a pair of parallel 24-inch Fort Union Gas Gathering system lines running south from near Gillette to the I-25 corridor west of Douglas. There is a 24-inch Thunder Creek Gas Services line also running south from fields northwest of Gillette to the I-25 corridor. There are two 16-inch lines running southerly from the Western Gas Resources processing plant near Wright to Douglas.

ES.2.10 Hazardous Materials and Wastes

The study area for hazardous materials and wastes includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area.

As industrial development in the PRB has increased, so too has the use of hazardous materials. Air, water, soil, and biological resources potentially could be affected by an accidental release or misuse of hazardous materials that could occur during transportation, storage, or use for various industrial activities.

In most cases, the regulated materials consist of products and materials that are used and consumed during industrial activities. Examples of such materials could include cement, fuel, solvents, acids, and a myriad of other chemicals and products. Often the hazardous constituents comprise a small percentage of the product being used, the rest of the material in the product being

inert or not defined as hazardous under any of the programs listed above. If these materials are not consumed during ordinary use and are regarded as waste, and if a waste is determined to be a hazardous waste, it must be handled and disposed of according to strict rules under the Resource Conservation and Recovery Act (RCRA). The RCRA program in Wyoming is delegated to the Hazardous and Solid Waste Division of the WDEQ. If the material to be discarded is determined not to be a hazardous waste, the material must be disposed of or recycled in a manner according to the statutes and regulations.

The primary hazardous materials that are consumed during coal mine operations include petroleum fuels and lubricants. The amounts of these materials would vary considerably from mine to mine based on production methods and overall output from the mine. The primary fuel used is diesel for excavators, heavy equipment, and haul trucks. The fuels are stored at the various mines in tanks (whether aboveground or underground) that have release containment systems and spill contingency plans to handle leaks and larger spills.

In addition to storage of fuels and lubricants in stationary tanks, mobile tanker trucks are used to provide fuel for excavators, haul trucks, and other equipment. Portable tanks and drums also are stored in a manner to prevent spills from reaching soils or water. Used oil is recycled to a licensed used oil recycler during the life of the mine.

During the operational lives of the mines, the probability of minor spills of materials such as fuel and lubricants would be relatively high. These releases could occur during fueling operations or from equipment failure (e.g., hydraulic hose failure). Spills of this nature would be localized, contained, and disposed of in accordance with the applicable laws and regulations. Accidents involving other hazardous materials also could occur during mine operation. The mines are required to develop and maintain a site-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan to deal with unplanned releases of petroleum products. They also have prepared Emergency Response Plans that establish procedures for responding to accidental spills or releases of hazardous materials to minimize health risks and environmental effects. The plans include procedures for evacuating personnel, maintaining safety, cleanup and neutralization activities, emergency contacts, internal and external notifications to regulatory authorities, and incident documentation. Proper implementation of the SPCC and Emergency Response plans has reduced the potential for major impacts associated with potential releases of hazardous materials.

Some of the materials listed above may become hazardous wastes (i.e., spent solvents). Materials that are considered hazardous must be accumulated, transported, and disposed of under very specific requirements. A review of the U.S. Environmental Protection Agency's Enforcement and Compliance History Online database indicates that the coal mines in the PRB do not generate large amounts of hazardous waste, and most of the mines are classified as Small Quantity Generators or Conditionally Exempt Small Quantity Generators.

Drilling operations for conventional oil and gas, and CBNG are very similar. Many of the potentially hazardous materials used in drilling the wells are the same. However, the amounts of material for CBNG wells are somewhat less, because the wells generally are much shallower. The materials used in these industries include fuels, lubricants, additives, and explosives. In addition to materials used in the drilling of wells, there are materials that are used and consumed in the production operations of oil and natural gas wells. Some materials may be used exclusively for oil well

operations and others used exclusively for gas wells and associated gas processing and compression.

Oil and gas well operators also must comply with requirements for the transportation, storage, use, and disposal of potentially hazardous materials. In addition, certain wastes derived from oil and gas drilling and production operations are exempt from regulation as hazardous wastes. Instead, these waste materials must be disposed or recycled according to applicable rules and regulations either under the jurisdiction of WDEQ or WOGCC. Examples of wastes that are exempt include produced water, drilling mud and cuttings, and completion and workover fluids.

In addition to the potentially hazardous materials that would be used and generated during oil and gas drilling and production operations, the products derived from these operations are considered hazardous. Oil, condensate, natural gas liquids, and methane can be considered hazardous materials either because of their volatility or explosive nature. There are standards and regulations that apply as well to the storage and transportation of these products.

Natural gas pipelines also would use potentially hazardous materials. Materials typically used in the construction and operation of transportation pipelines includes fuels (diesel, gasoline, methane), lubricants, water treatment chemicals, ethylene glycol, propylene glycol, methanol, sand blast media, and acids.

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
amsl	above mean sea level
APD	application for permit to drill
APLIC	Avian Power Line Interaction Committee
AUM	animal unit month
AVF	alluvial valley floor
BBS	breeding bird survey
BCF	billion cubic feet
BLM	Bureau of Land Management
BNSF	Burlington Northern and Santa Fe Railroad
C	custodial
CAPS	Cooperative Agricultural Pest Survey
CBNG	coal bed natural gas
CFR	Code of Federal Regulations
dB	decibels
dBA	decibels on the A-weighted scale
EA	Environmental Assessment
EC	electrical conductivity
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FR	Federal Register
FY	fiscal year
GAP	GAP Analysis Project
GIS	Geographic Information System
I	Improve
IHS	IHS Energy™
km	kilometer
LBA	lease by application
LQD	Land Quality Division
LRMP	Land and Resource Management Plan
M	Maintain
NAGPRA	Native American Grave Protection and Repatriation Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
ORV	off-road vehicle
OSM	Office of Surface Mining
PRB	Powder River Basin
PRRCT	Powder River Regional Coal Team
PSO	Public Service Company of Oklahoma
RA	Recreation Area
RCRA	Resource Conservation and Recovery Act
RMP	Resource Management Plan
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
SAR	sodium adsorption ration
SARA	Superfund Amendments and Reauthorization Act
SDD	State Decision Documents
SHPO	State Historic Preservation Office

SIO	Scenic Integrity Objectives
SMA	Special Management Area
SMCRA	Surface Mining Control and Reclamation Act
SMS	Scenery Management System
SPCC	Spill Prevention, Control, and Countermeasure Plan
SR	State Route
SSC	Species of Special Concern
STATSGO	State Soil Geographic (database)
STIP	Surface Transportation Improvement Program
TBNG	Thunder Basin National Grasslands
TCF	trillion cubic feet
THPO	Tribal Historic Preservation Officer
U.S.	United States
UP	Union Pacific
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOR	very high frequency omnidirectional range (flight navigation aid)
VRM	Visual Resource Management
WBN	Wyoming Bioinformation Node
WDEQ	Wyoming Department of Environmental Quality
WGFD	Wyoming Game and Fish Department
WIA	walk-in area
WOGCC	Wyoming Oil and Gas Conservation Commission
WSA	Wilderness Study Area
WSPHS	Wyoming Division of State Parks and Historic Sites
WSR	Wild and Scenic River
WYDOT	Wyoming Department of Transportation
WYNDD	Wyoming Natural Diversity Database

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The Powder River Basin (PRB) of Wyoming is a major energy development area with diverse environmental values. The PRB is the largest coal-producing region in the United States (U.S.); PRB coal is used to generate electricity within and outside of the region. The PRB also has produced large amounts of oil and gas resources. Within the last decade, this region has experienced nationally significant development of natural gas from coal seams.

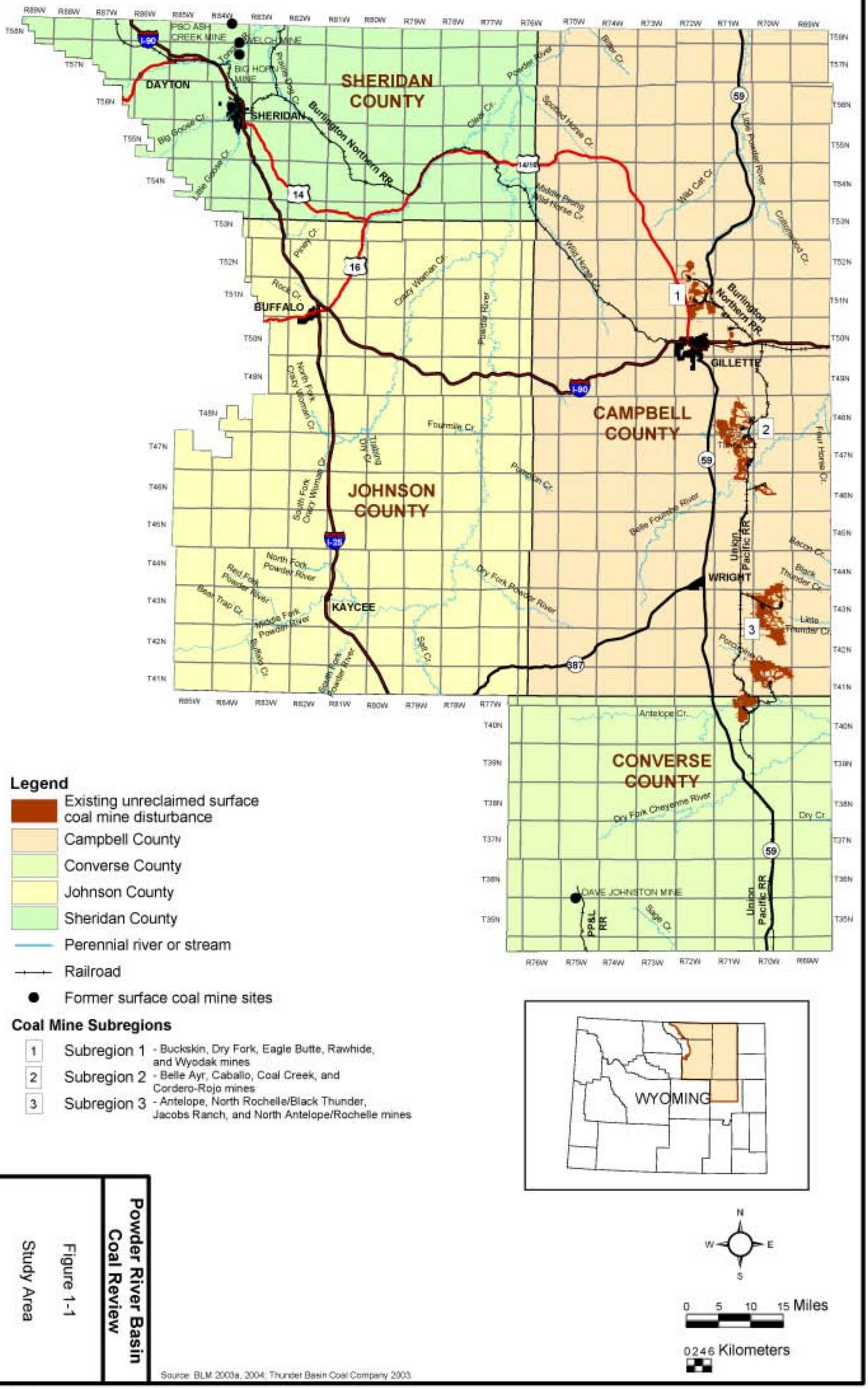
For the purpose of this study, the Wyoming PRB study area (**Figure 1-1**) comprises all of Campbell County, all of Sheridan and Johnson counties less the Bighorn National Forest lands to the west of the PRB, and the northern portion of Converse County. It includes all of the area administered by the Bureau of Land Management (BLM) Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the Thunder Basin National Grasslands (TBNG), which is administered by the U.S. Forest Service (USFS) (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**). In addition, the study area encompasses all or portions of 18 subwatersheds (fourth order) (**Figure 1-4**). The area of potential effect for the physical, biological, and human resources analyzed in this study varies by resource and in some cases extends outside of this study area, as appropriate.

During the 1970s and early 1980s, the PRB emerged as a major coal production region. Federal coal leasing was a high profile activity as over 90 percent of the PRB's coal is federally owned. Between 1974 and 1982, the BLM issued three and started a fourth separate regional coal environmental impact statement (EIS), all addressing federal coal leasing and development, as well as other regional development.

In 1982, the BLM temporarily halted further coal leasing. However, mining continued on existing leases. When leasing resumed in 1990, the existing mines were mature operations, and there was no need for regional leasing to open new mines. However, many of the mines were depleting their original reserves, so there was a need for maintenance leasing to provide reserves to enable existing mines to meet the expanding demand. The Powder River Regional Coal Team (PRRCT) decertified the region, allowing BLM to use the lease by application (LBA) process to meet this need. Each LBA required an EIS or environmental assessment (EA) as part of the leasing process.

Starting with the first LBAs, the BLM met the need for cumulative analysis in each EIS or EA with a discrete chapter addressing cumulative impacts. This approach served to highlight and focus cumulative impacts as distinct from site-specific impacts. With each subsequent EIS, the cumulative analysis was updated and new information added. In the mid-1990s, the BLM conducted a study called the PRB Coal Development Status Check to evaluate how actual development levels compared to the development levels predicted in the earlier regional EISs. The results of this study were presented to the PRRCT in 1996. Then, in the late 1990s, annual coal production and associated impacts drew closer to the maximum projections in the regional EISs. Furthermore, the large scale oil and gas development associated with coal bed natural gas (CBNG) development had not been foreseen in those EISs.

For the most recent LBAs, the BLM used the cumulative analysis from the Wyodak EIS (BLM 2000b) and PRB Oil and Gas EIS (BLM 2003a), particularly for air and water resources. Both EISs



Legend

- Existing unreclaimed surface coal mine disturbance
- Campbell County
- Converse County
- Johnson County
- Sheridan County
- Perennial river or stream
- Railroad
- Former surface coal mine sites

Coal Mine Subregions

1	Subregion 1	- Buckskin, Dry Fork, Eagle Butte, Rawhide, and Wyodak mines
2	Subregion 2	- Belle Ayr, Caballo, Coal Creek, and Cordero-Rojo mines
3	Subregion 3	- Antelope, North Rochelle/Black Thunder, Jacobs Ranch, and North Antelope/Rochelle mines

N W E S

0 5 10 15 Miles

0 2 4 6 Kilometers

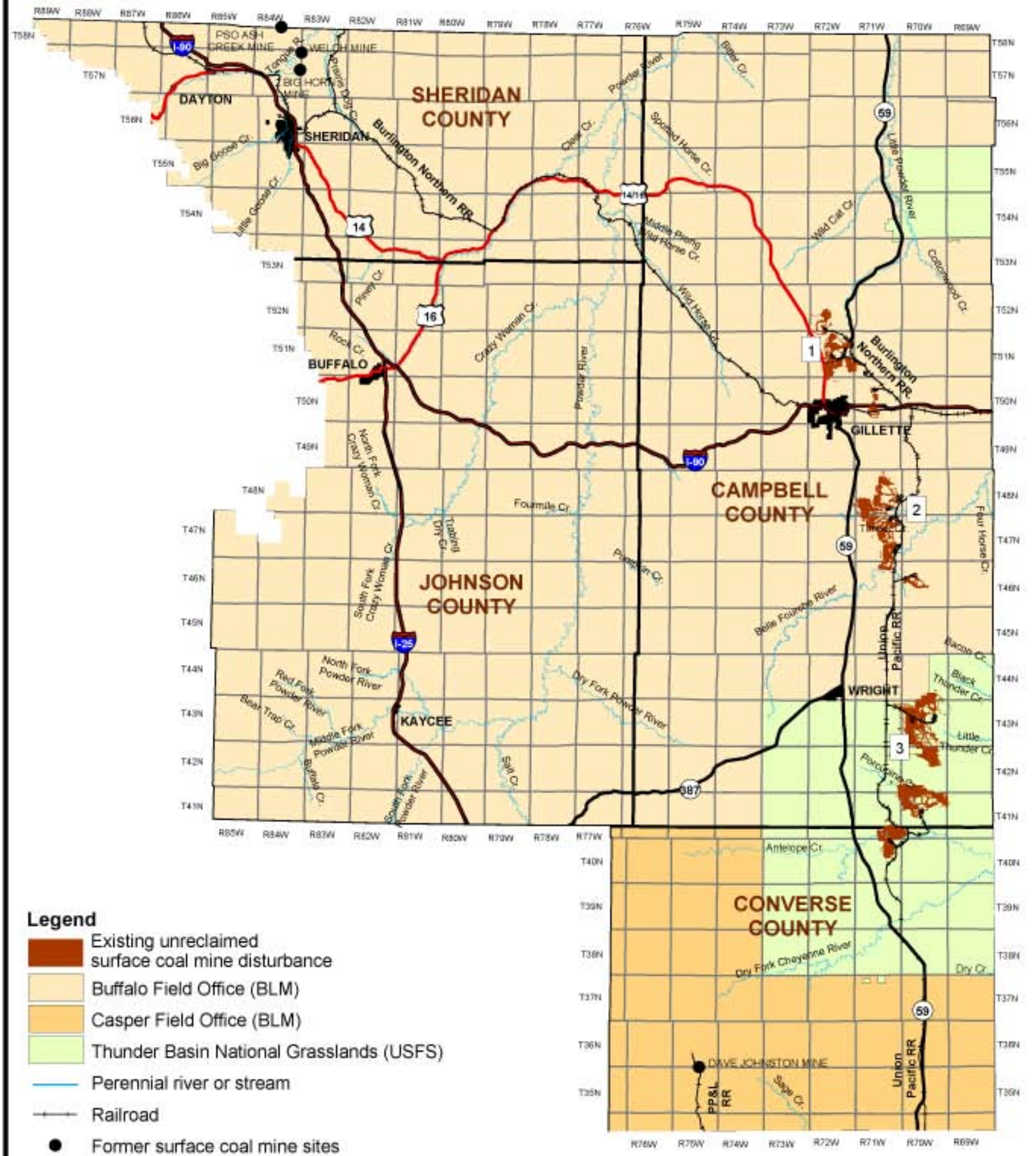
Powder River Basin Coal Review

Figure 1-1

Study Area

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003.

6/17/05



Legend

- Existing unreclaimed surface coal mine disturbance
- Buffalo Field Office (BLM)
- Casper Field Office (BLM)
- Thunder Basin National Grasslands (USFS)
- Perennial river or stream
- Railroad
- Former surface coal mine sites

Coal Mine Subregions

1. Subregion 1 (North Gillette)
2. Subregion 2 (South Gillette)
3. Subregion 3 (Wright)

N W E S

0 5 10 15 Miles

0 5 10 15 Kilometers

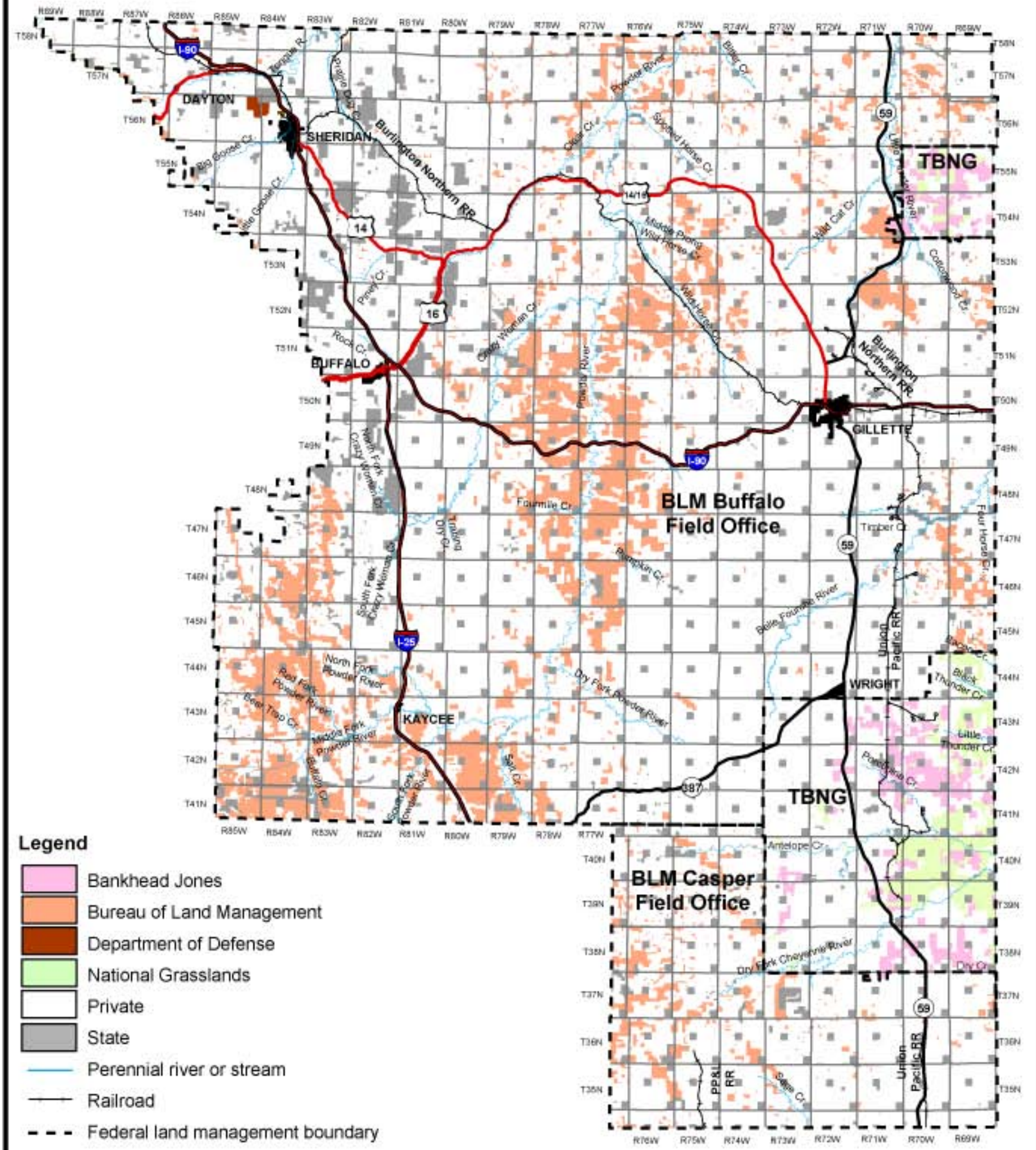
Powder River Basin Coal Review

Figure 1-2

Federal Land Management

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003

6/20/05



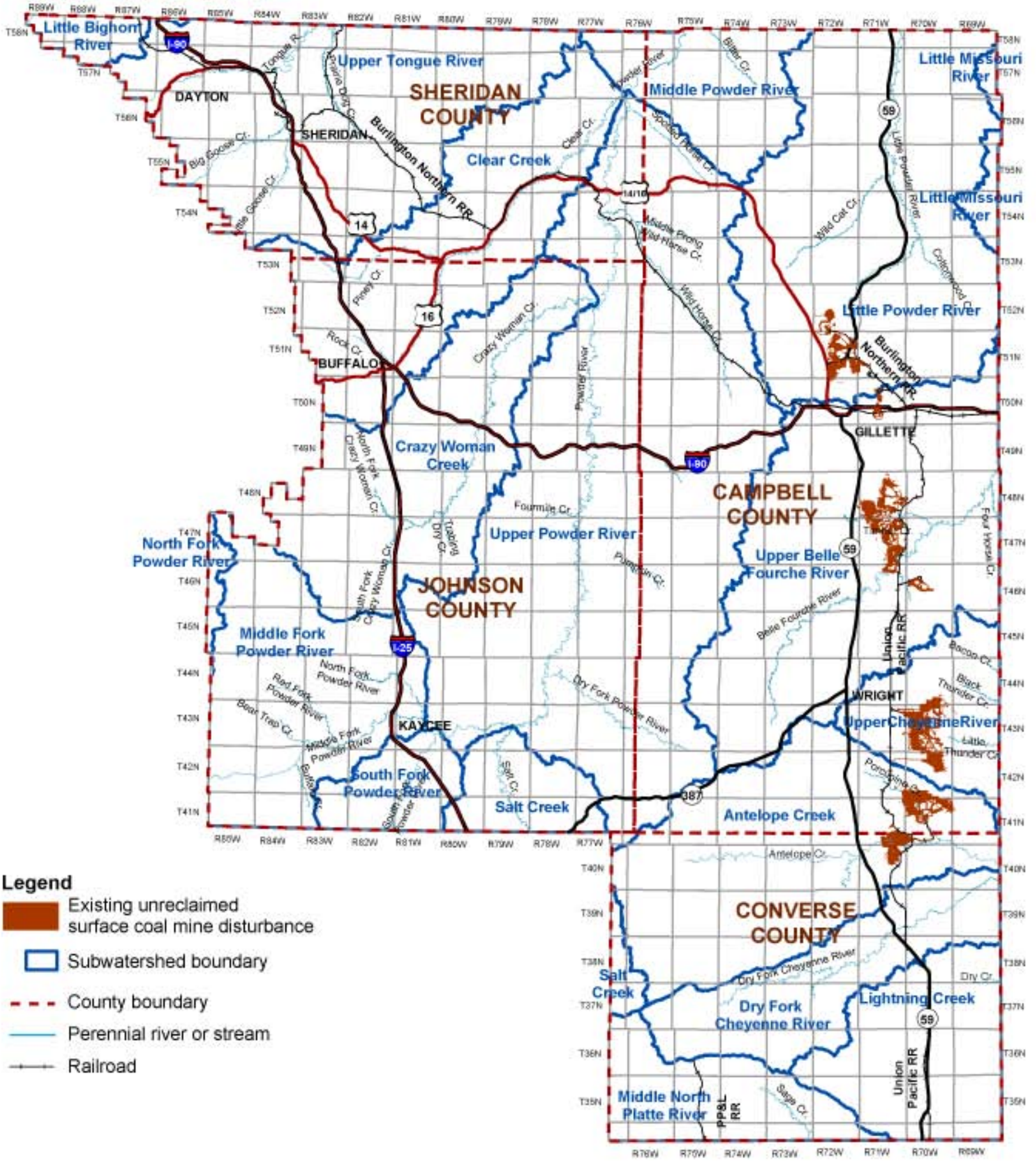
Powder River Basin Coal Review

Figure 1-3

Land Status

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003

6/20/05



Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003.

Powder River Basin Coal Review

Figure 1-4

Study Area Subwatersheds

6/20/05

projected regional development including CBNG activity. They both used market demand projections to estimate future levels of coal development.

In early 2003, BLM completed a study of PRB coal demand through 2020 (Montgomery Watson Harza 2003). The study projected production to increase at a steady pace with current mines able to meet the demand as long as the existing mines continue to have access to additional coal reserves; therefore, the need for leasing using LBAs will continue into the foreseeable future. As part of processing these LBAs, BLM will need to maintain a current cumulative impact analysis. An initial step in that direction is this PRB Coal Review, which includes the identification of current conditions in the PRB.

1.1 Objectives

This PRB Coal Review is a regional technical study to assess cumulative impacts associated with past, present, and reasonably foreseeable development in the PRB. The PRB Coal Review:

- Describes past and present (through 2000) development activities in the PRB that have affected the environmental conditions in the study area;

- Describes the current (through 2002-2003) environmental conditions in the study area and compares these conditions to the conditions projected in the BLM's Coal Development Status Check (BLM 1996), as applicable;

- Estimates reasonably foreseeable development in the study area through the year 2020, based on available information; and

- Estimates the environmental impacts associated with reasonably foreseeable development through the year 2020.

The PRB Coal Review will provide data, models, and projections to facilitate cumulative analyses for future agency land use planning efforts and for future project-specific impact assessments for project development in compliance with the National Environmental Policy Act (NEPA). It should be noted that the PRB Coal Review itself is not a NEPA document. It is not a policy study, nor is it an analysis of regulatory actions or the impacts of project-specific development.

This report summarizes Task 1 of the PRB Coal Review, a description of the current conditions associated with past and present coal production and other development in the PRB. This report describes the current environmental conditions for the following resources:

- Topography, geology, minerals, and paleontological resources;
- Soil and alluvial valley floors (AVFs);
- Vegetation including wetland and riparian areas;
- Wildlife, fisheries, and related habitat values;
- Grazing;
- Cultural resources and Native American concerns;
- Land use and recreation;
- Noise and visual resources;

- Transportation and utilities; and
- Hazardous materials and wastes.

The PRB Coal Review Task 1 descriptions of current conditions for air quality, water resources, and social and economic conditions are presented in separate stand-alone reports.

1.2 Agency Outreach, Coordination, and Review

The BLM directed the preparation of this PRB Coal Review. In order to ensure the technical credibility of the data, projections, interpretations, and conclusions of the study and ensure the study's usefulness for other agencies' needs, the BLM initiated contact with other federal and state agencies early in the study. This contact included meetings, periodic briefings, and written communications.

The BLM conducted an agency outreach program to solicit input from other agencies relative to their:

- Interested role and level of involvement in the study;
- Available data for use in the study;
- Input to the technical approach for resource evaluations; and
- Review of project deliverables.

The BLM provided periodic status updates to other agencies during the PRB Coal Review.

2.0 DESCRIPTION OF CURRENT CONDITIONS

This chapter presents the existing environmental conditions in the PRB study area, with the exception of water resources, air quality, and social and economic conditions, which are presented in individual baseline (Task 1) reports. The baseline information summarized in this chapter was obtained from published and unpublished information; interviews with local, state, and federal agencies; and the compilation of past and present actions in the Wyoming PRB, as presented in the Task 2 Report for the PRB Coal Review (ENSR 2005a).

The end of year 2003 existing disturbance acreages presented in this report were based on the database compiled for the Task 2 report and, where resource-specific data were required, the associated Geographical Information System (GIS) information. The existing disturbance acreages generated through GIS vary from the disturbance acreages in the Task 2 database due to the following variables. The information in the database was compiled based on information obtained from the data sources identified above and the applied assumptions defined in the Task 2 report. As a result, the database specifies a discrete disturbance acreage for each of the development activities (e.g., coal mines, individual oil and gas wells, etc.) identified for the study. Conversely, the GIS analysis accounted for the spatial relationship of the various development activities, thereby avoiding double counting of disturbance acreages where mapped disturbance areas overlap. In addition, the application of the new versus existing well disturbance acreage assumptions varied, as follows. For the database, the number of new wells developed in 2003 versus existing wells at the end of 2003 was quantified, and the appropriate acreage assumptions were applied. The observed ratio in the database between new and existing wells could be determined at the subwatershed level; however, the breakdown could not be applied to the resource-specific information within each subwatershed due to the lack of actual discrete locations for new versus existing wells in the GIS map layers. As a result, for GIS calculations purposes, the existing well acreage was applied to all (existing and new) wells in the GIS layer. Also, slight variations between the GIS study area boundary and GIS resource-specific layers resulted in some under counting of disturbance acreages. Where disturbance acreages are presented in this report, the appropriate source is noted.

2.1 Topography, Geology, Minerals, and Paleontological Resources

The description of existing conditions in the PRB study area for topography, geology, and minerals was based on the Final EIS and Proposed Plan Amendment for the PRB Oil and Gas Project (BLM 2003a). The information presented in that document was updated based on other information sources including the Wyoming Oil and Gas Conservation Commission (WOGCC) on-line production data, public BLM documents, IHS Energy Services™ (IHS) well data, Wyoming State Geological Survey and U.S. Geological Survey (USGS) publications, other published documents, and the past and present action descriptions presented in the PRB Coal Review Task 2 Report (ENSR 2005a).

The description of existing conditions in the PRB study area for paleontological resources was based on the Final EIS and Proposed Plan Amendment for the PRB Oil and Gas Project (BLM 2003a). Other regional EAs and EISs were reviewed; however, the need to update the information in the oil and gas EIS was not identified.

2.1.1 Key Issues

The key issues for topography, geology, and minerals are potential conflicts primarily involving mineral extraction issues. One concern is the potential conflict between CBNG operators and mine operators. Another concern is the potential loss of resources when one form of mineral extraction potentially results in the loss of another recoverable mineral resource. In addition to gross acreage disturbance, alteration of the land surface is a concern.

The key issue for paleontological resources is the potential loss of scientific and educational values due to the damage, destruction, or improper collection of fossil resources in association with development activities.

2.1.2 Study Area

The study area for topography, geology, minerals, and paleontological resources generally includes all or portions of Campbell, Johnson, Sheridan and Converse counties (**Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**). However, some historical predictions of mineral production trends came from documents (BLM 1996, 1981) that analyzed mineral production in project areas defined differently from this study area. Some information concerning the mineral production history occurred outside of the defined study area; however, this information is presented because of the relevance to the study area. In addition, certain aspects of general geology (stratigraphy, structural geology) are discussed for the entire PRB, including Montana.

2.1.3 Current Conditions

2.1.3.1 Topography and Physiography

The PRB is located within the Upper Missouri Basin Broken Lands physiographic subprovince that includes northeastern Wyoming and eastern Montana to the Canadian border (USGS 1970). The topography generally is of low to moderate relief with occasional buttes and mesas (Radbruch-Hall et al. 1980). The underlying bedrock in some areas is very erodible, which in places results in heavily dissected to badland-type topography. The general topographic gradient slopes down gently (generally southwest to northeast) with elevations ranging from 5,000 to 6,000 feet above mean sea level (amsl) on the southern and western portions of the basin to less than 4,000 feet amsl on the north and northeast along the Montana state line. The Wyoming portion of the basin is bounded on the west by the Big Horn Mountains and the Casper Arch, on the south by the Laramie Mountains, on the southeast by the Hartville Uplift, and on the east by the Black Hills **(Figure 2.1-1)**.

The major drainages in the basin flow from south to north or east to west and include the Tongue, Powder, Belle Fourche, and Cheyenne rivers (**Figure 1-1**). Most of the drainages in the area are intermittent and have flows during high precipitation events or during periods of snowmelt. The drainages are part of the upper Missouri River Valley drainage basin. The Tongue River flows from the Big Horn Mountains and drains a small portion of the northwestern part of the study area. The north-flowing Powder River and major tributaries also have head waters in the Big Horn Mountains and drain much of the western portion of the PRB. The Belle Fourche River flows northeast and its drainage basin occupies much of the northeastern part of the study area. The Cheyenne River drains the southeastern part of the PRB and generally flows to the east.

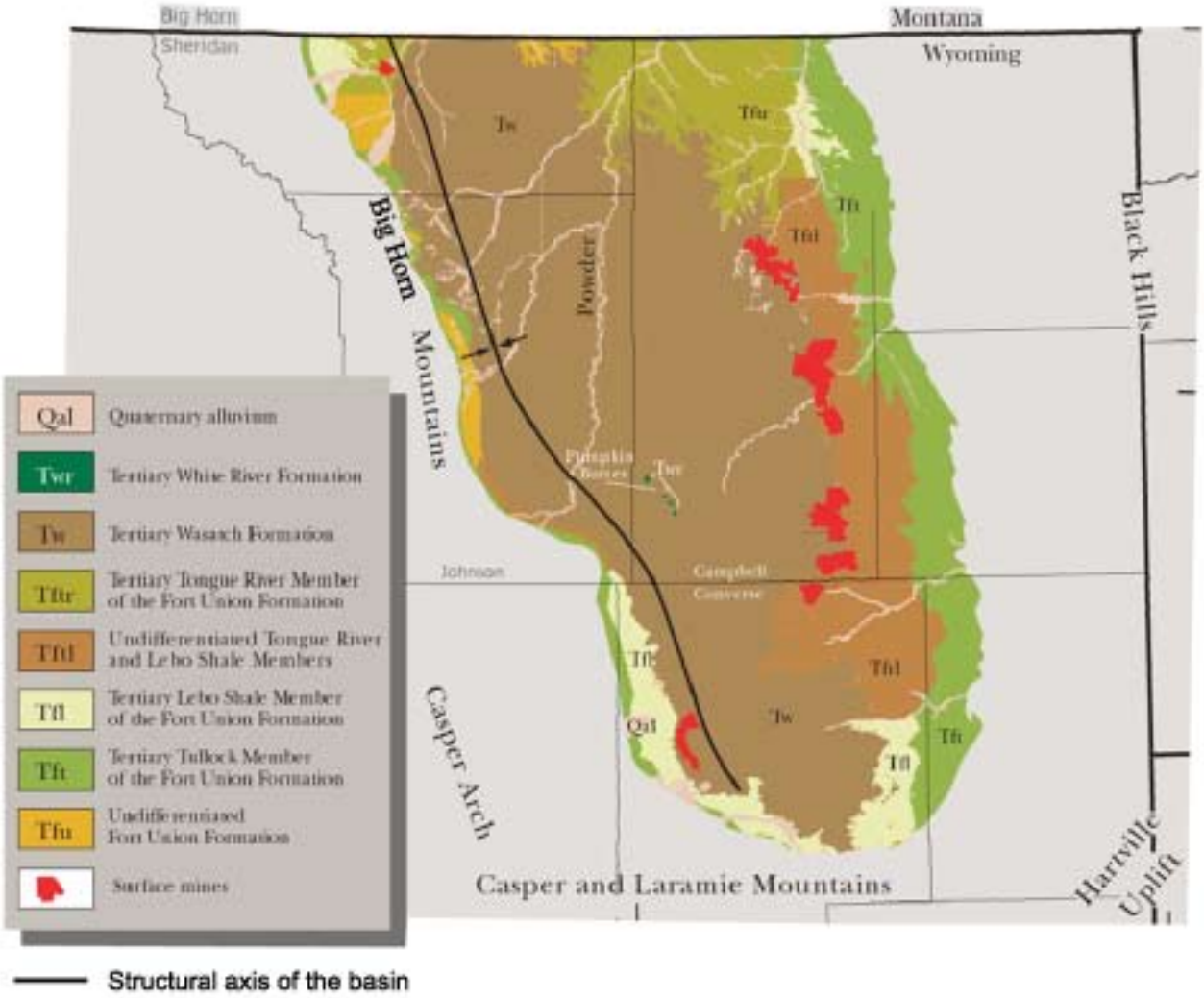
Surface coal mining alters the topography in mining areas by causing changes in slope, lowering the general land surface, and changing the physical nature of the surficial materials and overburden. The topography is affected only where mining occurs. Oil and gas exploration and development alter the landscape through leveling the land surface for drilling pads and cutting and filling during road construction. Oil and gas development affects topography to a much lesser degree than coal mining; however, it is more widespread than coal mining.

2.1.3.2 Geology

Statigraphy and Geologic History

The PRB contains Phanerozoic rocks (younger than Precambrian) over 17,000 feet in thickness. These rocks range in age from Cambrian to Tertiary (Love et al. 1993) **(Figure 2.1-2)**. In addition, there are unconsolidated alluvial and surficial deposits. Most of the rocks older than Tertiary outcrop along edges of the study area and also are found in the subsurface of the basin or are exposed along the margins of the basin. The following contains brief summaries of the rocks that are found in the study area.

Precambrian Era. The Precambrian rocks that are exposed in the adjacent mountain ranges and underneath the Phanerozoic rocks in the basin are complex assemblages of igneous and metamorphic rocks (Houston 1993). The Precambrian rocks are the oldest at billions of years old.



Powder River Basin Coal Review

Figure 2.1-1

General Geology of the Powder River Basin

Source: Flores et al. 2001.

06/02/05

Era	System	Series	Stratigraphic Units		
			West		East
Cenozoic	Quaternary	Holocene	Undifferentiated unconsolidated deposits		
	Tertiary	Oligocene	White River Formation		White River Formation
		Eocene	Wasatch Formation	Moncrief Member	Wasatch Formation
				Kingsbury Member	
		Paleocene	Fort Union Formation	Tongue River Member	
				Lebo Shale Member	
				Tullock Member	
Mesozoic	Upper Cretaceous		Lance Formation		Lance/Hell Creek Formation
			Fox Hills Sandstone		Fox Hills Sandstone
			Lewis Shale		Pierre Shale
			Mesaverde Formation	Teapot Sandstone Member	
				Parkman Sandstone Member	
			Cody Shale	Sussex Sandstone Member	Niobrara Formation
				Shannon Sandstone Member	Carlisle Shale
			Frontier Formation		
					Greenhorn Formation
					Belle Fourche Shale
	Lower Cretaceous		Mowry Shale		
			Muddy Sandstone		Newcastle Sandstone
			Thermopolis Shale		Skull Creek Shale
			Cloverly Formation		Fall River Formation
					Lakota Formation
	Jurassic		Morrison Formation		
			Sundance Formation		
			Gypsum Spring Formation		
	Triassic		Chugwater Group or Formation		Spearfish Formation
Paleozoic	Permian		Goose Egg Formation		Goose Egg Formation
					Minnekahta Limestone
					Opeche Shale
	Pennsylvanian		Tensleep Sandstone		Minnelusa
			Amsden Formation		
	Mississippian		Madison Limestone		Pahasapa Limestone
					Englewood Limestone
	Devonian		No Units		
	Silurian		No Units		
	Ordovician		Bighorn Dolomite		Whitewood Dolomite
			Harding Sandstone		Winnepeg Formation
	Cambrian		Gallatin Limestone		Deadwood Formation
			Gros Ventre Formation		
			Flathead Sandstone		
Precambrian			Precambrian rocks		

Source: Love et al. 1993.

Figure 2.1-2 Stratigraphic Chart for the Powder River Basin

Paleozoic Era. During early Paleozoic time, present-day Wyoming and much of the Rocky Mountain west were located along a fairly stable continental shelf (Lageson and Spearing 1991).

The area generally was inundated by shallow seas, and fluctuations in sea level resulted in the deposition or erosion of sediments. The rocks that were deposited on this shallow continental shelf were the result of numerous changes in sea level referred to as transgressions (relative rise in sea level); or regressions (relative falling of sea level or movement of coastlines seaward). Changes in sea level also caused many deposits to be eroded resulting in unconformities (or gaps) in the rock record. The rocks that were deposited from the Cambrian to Mississippian time period are typical of rocks that originally were deposited in a shallow marine environment. For instance, the Mississippian-age Madison Limestone is a massive carbonate that is widespread across Wyoming and is typical of conditions extant during the Paleozoic (Craig et al. 1972).

In the later Paleozoic, the sandstones of the Pennsylvanian represent an influx of sediment due to the uplift of the ancestral Rocky Mountains and a change to continental deposits in some areas. Erosion from the uplifts resulted in the deposition of the Tensleep Sandstone and equivalents across the Rocky Mountain region. In the study area, Pennsylvanian rocks on the west side of the basin are represented by the Amsden and Tensleep Formations (Love et al. 1993). On the east side of the basin, the Tensleep Formation equivalent is the Minnelusa Formation. During the Permian, conditions changed to alternating shallow marine to continental environments as indicated by the shale, limestone, and anhydrites of the Goose Egg Formation.

Mesozoic Era. During the beginning of the Mesozoic Era, northeastern Wyoming continued to be dominated by fluctuations of the western margin of North America. Early Mesozoic rocks of the Triassic System are represented by the Chugwater Group in the western part of the basin and the Spearfish Formation in the east. The formations are similar and consist of red shale, limestone, sandstone, and gypsum (Watson 1980). During the Triassic, the Wyoming shelf was emergent, and much of the deposits laid down were terrestrial in origin typified by the red beds and evaporites of the Chugwater Group (Picard 1993).

During middle Mesozoic Era, the Wyoming shelf alternated between emergent and submerged, resulting in Sundance Formation deposits of the Jurassic System. The Sundance Formation rocks are representative of a transgressive-regressive sequence during the middle and late Jurassic. The Sundance Formation consists of sandstone and shale. The Canyon Springs Sandstone Member of the Sundance Formation was deposited during the advance of the sea onto the Wyoming shelf (Picard 1993). The Canyon Springs often consists of a calcareous, oolitic sandstone with well-rounded and frosted quartz grains (Watson 1980). Generally, the upper portion of the Sundance Formation has more shale. At the end of the Jurassic, terrestrial conditions predominated resulting in the Morrison Formation, which is characterized by stream deposits that were laid down on an alluvial plain. The Morrison Formation, is characterized by shale of various pastel colors (often red, green, and purple) with interbedded sandstone, siltstone, and conglomerate (Watson 1980).

Rocks from the later part of the Mesozoic Era belong to the Cretaceous System. When describing Cretaceous rocks, they are usually divided into upper and lower Cretaceous. In the lower part of the lower Cretaceous are sandstones that are loosely correlated and referred to as the Lakota Conglomerate and Fall River Sandstone. The Lakota and Fall River are sometimes indistinguishable and make up the Inyan Kara Group. The sandstones occasionally are separated

by the Fuson Shale; however, it is often not present (McGookey et al. 1972; Watson 1980). Above the Inyan Kara Group is a black marine shale that in the western part of the basin is called the Thermopolis Shale and in the east is called the Skull Creek.

During the Cretaceous, a feature known as the Western Interior Seaway developed from the Gulf of Mexico to the Arctic Ocean (McGookey et at. 1972). During the Cretaceous, there were numerous episodes of transgressions and regressions that resulted in the deposition of thousands of feet of sedimentary rock. Following the deposition of the Lakota Conglomerate, the first major Cretaceous transgression began resulting in the deposition of the marginal marine Fall River Sandstone then the Thermopolis-Skull Creek Shale. A regression followed that resulted in the deposition of the widespread Muddy Sandstone. In northeastern Wyoming, the Muddy-equivalent is referred to locally as the Newcastle Formation.

The upper Cretaceous rocks consist of numerous formations that vary from west to east, indicative of the changing environments spatially and temporally across the basin during upper Cretaceous time. On the west side of the basin above the Muddy Sandstone, there are the Mowry Shale, Frontier Formation, Cody Shale, Mesaverde Formation, Fox Hills Sandstone, and Lance Formation. Above the Muddy-Newcastle Sandstone on the east are the Belle Fourche Shale, Greenhorn Formation, Carlile Shale, Niobrara Formation, Pierre Shale, Fox Hills Sandstone, and the Lance Formation (Love et at. 1993). The Mowry Shale is composed of black siliceous shale characterized by numerous bentonite beds (Watson 1980). The Carlile Shale is composed of non-calcareous shale and yellowish sands. The Niobrara Formation is composed of gray to black marine shale. The top of the Niobrara is often composed of limestone or calcareous shale (McGookey et al. 1972).

At the close of the lower Cretaceous, sea level rose and the Mowry Shale was deposited. The Frontier Formation resulted from several transgression-regression cycles and from west to east grades from fluvial to marine (Steidtmann 1993). The near shore and transitional marine deposits of the Frontier Formation in the western part of the basin grade to the east into the Belle Fourche Shale and Greenhorn Limestone, which represent shallow marine conditions. After the Frontier, the Niobrara transgression resulted in the deposition of the marine Carlile, Niobrara, and Pierre Shale sequence (McGookey et al. 1972). Following the Niobrara Transgression, a regressive sequence, the Mesaverde Formation, was deposited and is composed of sandstone and shale that were deposited in near-shore and marginal marine environments in western and central Wyoming, including portions of the PRB (Steidtmann 1993). On the east side of the PRB, the Mesaverde equivalent, the Pierre shale and associated sandstones, are marine in origin. The last major Cretaceous transgression resulted in the deposition of the Lewis Shale. Within the Lewis Shale are sandstones and siltstones that were deposited in marine and transitional marine environments (Van Horn and Shannon 1989). The last Cretaceous unit, the Lance Formation, was deposited under regressive conditions and is composed of sandstones, carbonaceous shale, and coal (Watson 1980).

Cenozoic Era. The earliest Tertiary System rocks (Paleocene Series) are the Fort Union Formation that is composed of sandstone, conglomerate, shale, and coal (Watson 1980). The depositional environments of the Fort Union consisted of fluvial systems with flood plains and peat swamps (Flores et al. 1999). The Fort Union is the major coal-producing unit in the region; the detailed stratigraphy of this unit is discussed in the Coal Resources subsection of Section 2.1.3.3, Mineral Resources. Eocene Series rocks in the PRB are represented by the Wasatch Formation, which generally is described as being composed of distinctively colored (pastel green, pink, and yellow)

mudstone, sandstone, and siltstone (Watson 1980). The Wasatch Formation also contains numerous coal beds (Flores et al. 1999). There are two distinct members of the Wasatch Formation in the northern part of the PRB, the Kingsbury Conglomerate and the Moncrief Gravel. The Oligocene Series White River Formation is the youngest of the Tertiary formations in the PRB. The White River is composed of mudstone, sandstone, and conglomerate with volcanic ash beds (Watson 1980).

Near the end of the Cretaceous, mountain building began in western Wyoming. As the mountains were uplifted, erosion occurred and sediment was transported into the shallow Cretaceous seaway. In the PRB, the uppermost Cretaceous unit, the Lance Formation, was derived from alluvial plain deposits marking the end of the Cretaceous (Lilligraven 1993). Also at the end of the Cretaceous and the beginning of Tertiary time, another episode of mountain building was occurring in the area. This episode of mountain building is referred to as the Laramide Orogeny (Lageson and Spearing 1991). Uplift of the Precambrian basement occurred through the movement of Precambrian basement blocks along low- to high-angle reverse faults. This period of mountain building resulted in the mountain ranges that are adjacent to the basin: the Big Horn Mountains, the Laramie Mountains, and the Black Hills. The Hartville Uplift is also of Laramide origin. The uplifted blocks of basement rock were eroded, and the sediment was deposited resulting in the Fort Union and Wasatch formations.

In the later Tertiary (Oligocene-Miocene), large volcanic eruptions occurred to the west and north of the area. Prevailing winds carried the ash aloft over an extensive area, and thick layers of ash were deposited as a result of these eruptions. These ash deposits are found in the White River Formation. Erosion along the mountain fronts has removed the mantle Tertiary deposits in most places resulting in abrupt changes in elevation along the mountain fronts.

Unconsolidated Quaternary deposits consist of alluvium, terraces, colluvium, gravels, and pediments (Love and Christiansen 1985). Alluvial deposits generally are associated with alluvial valleys of the major rivers and tributaries.

Structural Geology

The PRB is one of a number of structural basins in Wyoming and the Rocky Mountain area that were formed during the Laramide Orogeny. The basin is asymmetric with a structural axis that trends generally northwest to southeast along the western side of the basin (Flores et al. 1999). From the eastern margin of the basin, the rocks dip from 2 to 5 degrees to the structural axis (**Figure 2.1-1**). From the western edge of the basin, the rocks generally dip approximately 20 to 25 degrees to the axis of the basin. Along the margins of the basin adjacent to the Big Horn Mountains, Laramie Mountains, and the Hartville Uplift are large-scale reverse faults where blocks of the basement-cored uplifts were displaced during the Laramide Orogeny. Other structural elements by which the basin is structurally defined are the Black Hills to east, the Casper Arch on the southwest **(Figure 2.1-1)**, and the Miles City Arch on the north in Montana. These elements are structurally high, but there are no major bounding faults or dislocations. Along the west side of the Black Hills, gently dipping sedimentary rocks ramp onto the Precambrian core of the Black Hills with only minor faults (Grose 1972). The Casper Arch is a broad anticlinal area that trends northwest from the north end of the Laramie Mountains to the Big Horn Mountains. The Miles City Arch is a gentle anticlinal feature that trends northwest from the Black Hills and forms the north structural boundary of the PRB in Montana that separates it from the Williston Basin to the north. In addition

to the major structural elements that define the basin, there are a number of folds on the western and southern margins of the basin. Much of the basin has very little internal structure, and the large area of west-dipping rocks east of the basin axis contains few, if any, major folds or dislocations.

Geologic Hazards

Earthquakes occur when energy is released as blocks of the earth's crust move along areas of weakness or faults. There are no identified active faults in the study area (USGS 2004). An active fault is a fault that has demonstrated movement within the last 11,000 years. The study is located in an area of low risk from ground shaking if a maximum credible earthquake were to occur in the region (Frankel et al. 1997).

Most of the project area is underlain by Cretaceous and Paleocene shale, siltstone, and sandstone. These rocks have high clay content and can be very unstable. Geologic formations in the project area that are known to be very susceptible to landslides are the Pierre Shale, Cody Shales, and the Paleocene-age Fort Union Formation (Radbruch-Hall et al. 1980). Landslide occurrence is greatest along the Powder River in Johnson and Sheridan counties and along the Little Powder River north of Gillette (BLM 2003a). Slope instability also can occur in surface mine highwalls.

The PRB Oil and Gas EIS (BLM 2003a) discussed a number of potential hazards that could be associated with CBNG production. The potential hazards discussed were landslides, subsidence, gas seepage, and spontaneous combustion. There was no evidence of the occurrence of any of the aforementioned hazards in relation to CBNG production within the PRB.

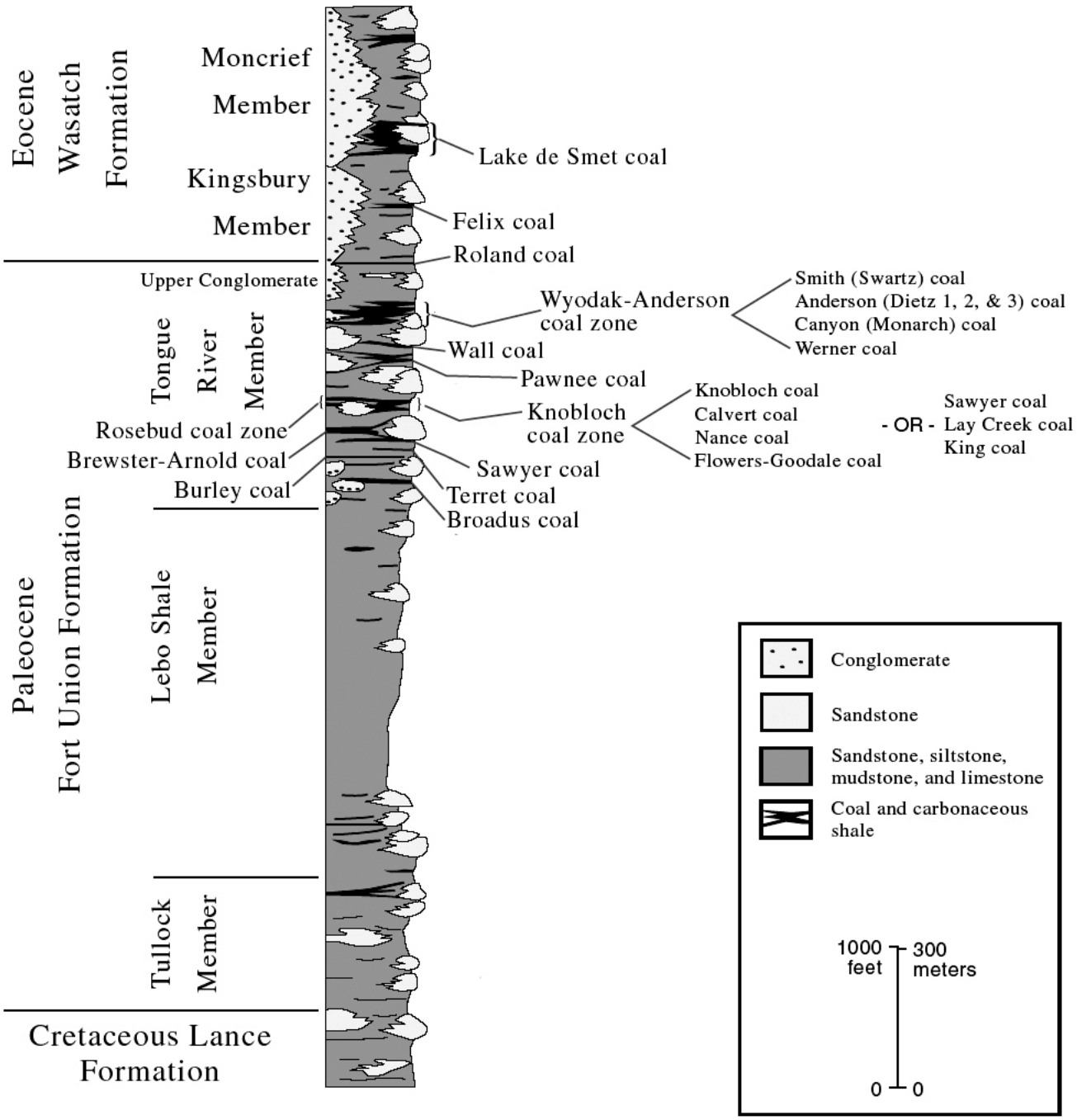
2.1.3.3 Mineral Resources

Coal Resources

Geology and Stratigraphy of the Fort Union Formation. Most of the coal resources of the basin are found in the Fort Union and Wasatch formations. Most of the coals are in the Paleocene Fort Union Formation. Although coals are present in the Wasatch, they are not as economically important as the coals in the Fort Union. The following is a general description of the stratigraphy of the Fort Union Formation.

The Fort Union and equivalent strata were deposited across a broad area of the Rocky Mountain Region from Northwestern Colorado to Montana and western North Dakota. In the PRB, the formation ranges in thickness from over 5,200 feet in the west to 2,300 feet in the east (Curry 1971). The thickest part of the formation is found along the structural axis of the basin (see **Figure 2.1-1**). The Fort Union is divided into three members and from oldest to youngest are the Tullock, Lebo, and Tongue River (**Figure 2.1-3**). The Tullock Member is up to 740 feet thick and consists of yellow calcareous sandstone and shale and carbonaceous shale beds (Watson 1980). The Lebo Shale Member consists of shale and interbedded sandstone. The Tongue River Member is composed of massive sandstone, shale, and thick coal beds. The coal beds in the Tongue River Member range from a few inches to more than 200 feet thick (Flores et al. 1999).

The Tongue River Member of the Fort Union Formation contains most of the economically important coal zones. The initial understanding of the coal stratigraphy in the PRB was based on the assumption that coal seams in the Tongue River Member were laterally continuous over many



Powder River Basin Coal Review

Figure 2.1-3

Stratigraphic Column
Ft. Union and Wasatch Formations

Source: Flores et al. 2001.

03/16/05

miles (Flores and Bader 1999). However, with the advent of more data associated with the large number of drill holes for coal exploration, CBNG, non-CBNG, and oil, the coal stratigraphy is now thought to be more complex. A number of coal seams have been identified and mapped in the Wyoming portion of the PRB (**Figure 2.1-3**). Coal stratigraphy is complex due to the nature of the environments in which the coal was originally deposited. The swamps (where the organic material that is deposited and eventually becomes coal) associated with the fluvial systems are not often laterally continuous over many miles or aerial extent. Often coals split (one bed becomes several beds), overlap, or end abruptly. It is not possible to detect these discontinuities without the aid of numerous outcrop and borehole sampling points.

Coal Quality. Coal quality for the Wyodak-Anderson coal is shown in **Table 2.1-1**. The information in **Table 2.1-1** was derived from numerous coal samples from the Wyodak-Anderson coal which produces from over 20 mines in the PRB (Stricker and Ellis 1999). As a result, the values in the table provide a general representation of the Wyodak coal. The data indicate that the coal is subbituminous, generally low sulfur, and has low concentrations of metallic constituents. The low sulfur nature of the coal has made it sought after because of its cleaner burning characteristics for power generation. Often utilities will blend PRB coal with higher sulfur coals in order to achieve air quality emissions compliance.

Table 2.1-1
Analytical Results for Coal in the Wyodak-Anderson Coal Zone[1]

Variable	Number of Samples	Range		Mean
		Minimum	Maximum	
Moisture[2]	300	14.50	42.30	27.66
Ash[2]	279	2.86	25.06	6.44
Total sulfur[2]	279	0.06	2.40	0.48
Calorific value[3]	277	3,740.00	9,950.00	8,220.00
Sulfur dioxide (pounds)[4]	277	0.14	7.88	1.24
MMMFBtu[5]	277	4,580.00	10,560.00	8,820.00
Antimony[6]	144	<0.01	17.00	0.49
Arsenic[6]	158	<0.20	19.00	2.60
Beryllium[6]	151	<0.078	3.30	0.54
Cadmium[6]	151	<0.007	3.00	0.21
Chromium[6]	161	<0.59	50.00	6.10
Cobalt[6]	160	<0.38	27.00	1.90
Lead[6]	162	<0.50	17.00	3.00
Manganese[6]	161	0.18	210.00	26.00
Mercury[6]	162	<0.006	27.00	0.13
Nickel[6]	161	<0.71	35.00	4.60
Selenium[6]	151	<0.08	16.00	1.10
Uranium[6]	157	<0.11	12.00	1.30

[1]Samples collected from the Wyodak-Anderson coal zone in the Wyoming and Montana PRB.
[2]Values are in percent and on an as-received basis.
[3]Value is in British thermal units (Btu).
[4]Value is in pounds per million Btu and on an as-received basis.
[5]Value is in Btu on a moist, mineral-matter-free (MMMF) basis.
[6]Values are in parts per million (ppm) on a whole-coal and remnant moisture basis.

Source: Stricker and Ellis 1999.

Conventional Oil and Gas

Drilling for non-CBNG resources has declined considerably in the last 15 years (from a high of 199 in 1990 to 32 in 2003) averaging 100 wells per year for all categories of wells (production, injection, wildcats) (IHS 2004). However, there remains potential for finding and developing non-coal bed production in the deeper areas of the basin. The USGS (2002) estimates that the PRB (Wyoming and Montana) may have undiscovered hydrocarbon resources (mean) of 1.5 billion barrels of oil and 1.2 trillion cubic feet of gas (non-CBNG). Much of this resource may be in the deeper sparsely drilled parts of the basin.

Waning interest in oil can be seen in the decline of oil production. In 2003, conventional oil and gas production from the PRB was approximately 19.5 million barrels of oil and 47 billion cubic feet (BCF) of gas (WOGCC 2004). That compares with a production of 50.5 million barrels of oil and 64.4 BCF of gas in the PRB in 1989; CBNG production in 1989 was insignificant. Per IHS (2004) data, non-coal bed hydrocarbon production from the PRB study area in 2003 was 12.9 million barrels of oil and 40 BCF gas. There were approximately 3,500 active conventional oil and gas wells at that time in the PRB (not counting seasonally produced wells) (ENSR 2005a).

CBNG

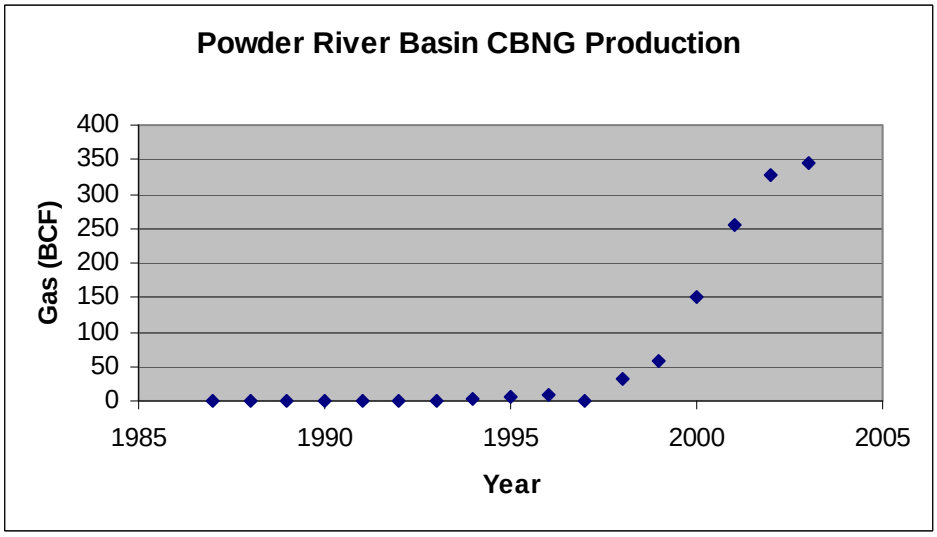
Total production for 2003 was 346 BCF, or 88 percent of the total gas production from the basin (WOGCC 2004); per IHS data, production in 2003 was 338 BCF (ENSR 2005a). From 1987 to 2003, the total cumulative gas production from PRB coals was over 1.2 trillion cubic feet, and the total cumulative water production was approximately 2.3 billion barrels (ENSR 2005a). As can be seen on the chart of yearly CBNG production **(Figure 2.1-4)**, annual CBNG production increased rapidly from 1999 through 2002 and appears to have started to level off in 2003. Annual water production (**Figure 2.1-4**) increased between 1999 and 2002, but started to decrease slightly in 2003.

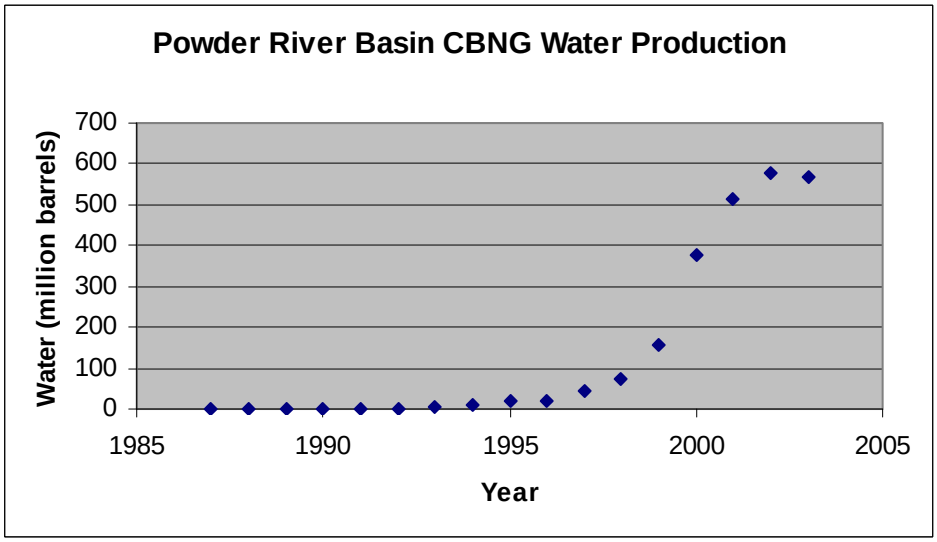
Other Mineral Resources

Other mineral resources in the PRB study area include uranium, bentonite, clinker, and aggregate. Uranium is found in the Wasatch, Fort Union, and Lance formations. There are three defined uranium districts in the PRB; Pumpkin Buttes, Southern Powder River, and Kaycee (BLM 2003b). Numerous uranium mining sites were present in these districts, but were mined out or uneconomic. Uranium currently is mined in the Southern Powder River District at Smith Ranch and Highland/Morton Ranch (Harris 2003). Uranium is produced by the in situ leach method at both locations (Harris 2003). Wyoming produced 1.6 million pounds of yellowcake (the raw uranium production material) in 2002. There are several bentonite localities in the PRB and bentonite in the study area is mined at Kaycee, Wyoming (Wyoming Mining Association 2004). Clinker is formed when coal beds burn and the adjacent rocks become baked. Clinker is used as road surfacing material and is found in extensive areas in the study area (BLM 2003b). Terrace and alluvial deposits associated with the larger streams in the study area are mined for sand and gravel. The more important aggregate mining localities are in Johnson and Sheridan counties (USGS 2003b).

2.1.3.4 Paleontological Resources

The paleontological resources found on public lands are recognized by the BLM as constituting a fragile and nonrenewable scientific record of the history of life on earth, and so represent an





Source: WOGCC 2004.

Figure 2.1-4 Annual CBNG and Water Production

important and critical component of America's natural heritage. Once damaged, destroyed, or improperly collected, their scientific and educational value may be greatly reduced or lost forever. In addition to their scientific, educational, and recreational values, paleontological resources can be used to inform land managers about interrelationships between the biological and geological components of ecosystems over long periods of time.

While there are no laws specifically aimed at the management of paleontological resources, a number of laws address paleontology. For example, the Archaeological Resource Protection Act of 1979 (16 USC 470ee) prohibits the unauthorized removal of fossils that are in an archaeological context. The Federal Cave Resources Act of 1988 (16 USC 4306) prohibits the removal of paleontological resources when they are taken without authorization from a designated significant cave. The BLM utilizes other more general laws and authorities to protect paleontological resources. These laws include Theft of Government Property (18 USC 641), Damage to Government Property (18 USC 1361), and the Federal Land Policy Management Act (43 USC 1733).

In addition, BLM Manual 8720, *General Procedural Guidance for Paleontological Resource Management*, is intended to provide a consistent and comprehensive approach to the management of paleontological resources including identification, evaluation, protection, and use (BLM 1998).

Scientifically significant paleontological resources, including vertebrate, invertebrate, plant, and trace fossils, are known to occur in many of the geologic formations within the study area. These fossils are documented in the scientific literature, in museum records, and are known by paleontologists and land managers familiar with the area.

The paleontologic potential of the study area was evaluated using the Probable Fossil Yield Classification developed by the USFS and used by the BLM. The classifications include:

- Class 1: Igneous and metamorphic geologic units (excluding tuffs) that are not likely to contain recognizable fossil remains.

- Class 2: Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant nonvertebrate fossils.

- Class 3: Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence.

- Class 4: Class 4 geologic units are Class 5 units that have lowered risks of human-caused adverse impacts or lowered risk of natural degradation. Proposed ground-disturbing activities would require assessment to determine whether significant paleontological resources occur in the area of a proposed action and whether the action would impact the resources.

- Class 5: Highly fossiliferous geologic units that regularly and predictably produce vertebrate fossils or scientifically significant nonvertebrate fossils and that are at high risk of natural degradation or human-caused adverse impacts.

There are 34 mapped geologic units (Flores et al. 2001; Love et al. 1987) within the study area. Of these, 1 is classified as Class 1, 2 are classified as Class 2, 27 are classified as Class 3, none are classified as Class 4, and 4 are classified as Class 5. The 4 units classified as Class 5 are the Morrison, Lance, Wasatch, and White River formations.

Most of the geologic formations exposed at the surface within the study area are exposed only along the margins of the PRB. The most widely distributed units are the Wasatch and Fort Union formations, both of which are discussed below. The Morrison and Lance formations outcrop in the western portion of the basin; however, in the vicinity of the coal mines and CBNG activity in the eastern portion of the basin, these formations occur at depth. Within the study area, the highly fossiliferous White River Formation (Class 5) occurs only on Pumpkin Buttes in southwestern Campbell County.

The Wasatch Formation (Class 5) is by far the most geographically widespread formation in the study area and is the bedrock geologic formation exposed at the surface in most of the basin (Murphey et al. 2001). Because surface exposures are mostly vegetated, the formations within the PRB historically have not been perceived to be as rich in fossils as nearby basins, such as the Bighorn and Wind River, which have extensive badland exposures. Nevertheless, the ubiquitous anthills in the basin contain locally abundant remains of small animal fossils (mouse to rabbit sized), which can be successfully sampled even in vegetated areas.

Murphey et al. (2001) discovered that no institution has collected articulated bones from the lower Eocene part of the Wasatch Formation in the PRB. The Eocene-age fossils consist primarily of isolated teeth, with more complete dental or upper jaw fragments comprising approximately 10 percent of the total number of specimens in the University of Colorado Museum's collections. Articulated material, particularly a partial skeleton of the reptile *Champsosaurus gigas*, is known from older deposits of the Wasatch Formation. Such finds are very rare and appear to be restricted to the Paleocene-age part of the formation. The Wasatch Formation fossil localities include 106 localities recorded at the University of Colorado Museum, 4 localities recorded at the University of Wyoming Museum of Geology, and 46 localities listed in Delson (1971), who was collecting for the American Museum of Natural History. These localities originally were documented by Wood (Delson 1971).

The Fort Union Formation (Class 3) is not as widely distributed as the Wasatch Formation, but occurs around the margins of the basin. This formation contains locally abundant fossil vertebrates, invertebrates, and plants, and displays an important time interval during the early Tertiary evolution of mammals. No fossil localities in the Fort Union Formation within the study area were identified during the museum record search for this analysis; however, they do occur nearby in Montana.

Other fossil localities occur in the Mesaverde, Mowry, White River, and Gros Ventre formations. Fossil localities outside the study area and within formations that extend beyond the study area boundary also were identified during this analysis. Data from fossil localities outside the study area were used in the class designations recommended for formations that occur within the study area.

The lack of localities from any of the geologic units in the study area does not mean that scientifically significant fossils are not present. Much of the area within and surrounding the PRB in Wyoming has not been adequately explored for paleontological resources, and new scientifically significant fossil occurrences are being discovered regularly.

2.1.4 Comparison to Previous Predictions

2.1.4.1 Topography and Physiography

PRB coal leasing NEPA documents (BLM 1973, 1979, 1981, 1984, 1994, 1995a, 2000a,b, 2003c) describe potential effects to topography from coal mining. Some of these effects can include changes to slopes from the original land surface, lower average surface elevation of the mined tract, and increased the homogeneity of backfilled materials compared to the original overburden. The Powder River Regional Coal Final EIS (BLM 1981) and the Coal Development Status Check (BLM 1996) did not address topography as a separate impact topic; however, the EISs listed above indicated that direct impacts to topography would be "insignificant." It did not identify the potential impacts. The effects identified above are based on decades of surface mining in the area. The magnitude of such effects appear to be predictable depending on particular site characteristics including thickness and volume of coal seams, overburderden, and interburden; bulking characteristics of overburden and interburden material; and slope of the original land surface. The Coal Development Status Check compared predictions to actual numbers of acres that were disturbed and reclaimed. The recent documents do not identify a level of significance of the topographic impacts.

2.1.4.2 Geology

The Powder River Coal Region Final EIS (BLM 1981) described the direct impacts to geology as permanent removal of the coal and destruction of the overlying strata. In addition, it was stated that the impacts of coal removal would be long-term and irreversible. Other documents (BLM 1994, 1995a, 2000, 2003c) describe impacts in terms of physical aspects of the overburden and the changes that occur during coal mining and the potential loss of coal that is not readily mineable. The Coal Development Status Check (BLM 1996) does not address impacts to geology. Loss of unrecoverable coal would be an irretrievable impact. Those conclusions would be an accurate assessment of the current impacts of coal mining to geology in the PRB study area.

The Powder River Coal Region Final EIS (BLM 1981) and the Coal Development Status Check (BLM 1996) did not identify geological hazards with regard to coal mining, nor do the more recent NEPA documents (BLM 1994, 1995, 2000, 2003b). The PRB Oil and Gas Final EIS (BLM 2003a) describes potential geologic hazards with respect to oil and gas extraction (e.g., subsidence, gas seepage, and spontaneous combustion). To date, no evidence has been presented to change the conclusions in the PRB Oil and Gas Final EIS (BLM 2003a) concerning CBNG production and potential hazards.

To summarize, impacts to geology occur within the mining areas, are part of the mining process, and are permanent. The area of impacts to overburden geology is the same as the direct mining disturbance associated with the removal of soil, overburden, and coal. The cumulative effects increase incrementally for each year of mining and would continue as long as mining occurs.

2.1.4.3 Mineral Resources

Coal Resources

In the Powder River Coal Region Final EIS (BLM 1981), it was estimated that selection of the preferred alternative in that EIS would result in an annual production of approximately 318.4 million tons of coal by 1990 (Campbell and Converse counties, Wyoming) (BLM 1981, 1996). Actual production for those counties in 1990 was 162.6 million tons. Actual production did not reach the predicted 1990 level until 1999, when 320 million tons were mined (Lyman 2003). The differences between the predicted and actual tonnages may be due to a variety of factors. Low energy prices in general in the 1980s and the early 1990s did not encourage transporting Powder River coal into more markets. However, by the late 1990s, Powder River coal was making great gains because of increasing demand by out-of-state utilities to meet increasingly stringent air quality standards, the stable price for Wyoming coal compared to other important low-sulfur fuel (natural gas), and the competitive price compared to other fuels. The annual coal production in 2003 was 363 million tons (ENSR 2005a).

In the 1970s and 1980s, several projects were proposed to convert coal into gas (by plant or in situ methods) and convert coal into synthethic liquid fuel (BLM 1981). Most of these proposed projects were never implemented, because low energy prices in the 1980s and 1990s made such projects commercially infeasible. Although three test facilities were constructed, no commercial production has occurred; these facilities either have been dismantled or are no longer in use (ENSR 2005a).

Conventional Oil and Gas Resources

In 1979, the BLM predicted that oil and gas production in Campbell and Converse counties would be approximately 33.6 million barrels of oil in 1990 (BLM 1996). The actual production was approximately 31.4 million barrels. Also in 1979, it was predicted that natural gas production in the counties would be 48.2 BCF in 1990. The actual gas production was 50.8 BCF. The annual production in 2003 was 12.9 million barrels of oil and 378.3 BCF of natural gas (ENSR 2005a).

CBNG

Recent recoverable resource estimates for CBNG range from 16 to 28 trillion cubic feet (TCF) of gas (BLM 2001a). The Powder River Coal Region Final EIS (BLM 1981) did not address CBNG. In 1990, the BLM prepared an EA in which it was estimated that within the EA study area of southwestern Campbell and eastern Johnson counties, there was a CBNG resource of 27 TCF. This earlier estimate was based on available data at the time and was without regard to production economics, only estimated gas in place. However the estimate is remarkable in its accurate order of magnitude in comparison with later estimates based on several years of production and better knowledge of gas in place. The EA estimated that 1,000 CBNG wells would be drilled and over a 20-year period potentially could recover approximately 301 BCF of the estimated resource (1.1 percent). The EA was conducted in an effort to determine the potential effects of CBNG production. As discussed earlier, only a few CBNG wells had been drilled up to that time; soon after the EA was issued, industry interest in the CBNG play waned because of disappointing results of the early developments. However, by the mid-1990s, there was renewed interest in the play and as discussed above, activity began to increase at geometric rates.

The number of producing wells as of the end of 2003 appears to be consistent with relatively recent BLM projections of drilling activity (BLM 2001a). Over 12,900 CBNG wells were in production at the end of 2003, and an additional 1,800 wells were completed and shut-in and presumably soon to be in production (ENSR 2005a). This number is in the BLM's estimated range for productive wells by the end of 2003 for the low to medium (16 to 23 TCF) resource recovery scenarios (BLM 2001a).

Other Mineral Resources

In 1979, the predicted uranium production for 1990 was approximately 4.7 million tons, and the actual production was approximately 524 tons (BLM 1996). In the period from 1979 to 1990, the demand for uranium fuel in the U.S. plummeted as a result of the Three-Mile Island nuclear power plant disaster.

In 1979 it was estimated that sand, gravel, and scoria mining would disturb 1,280 acres in 1990 (BLM 1996). The actual disturbance was 162 acres in 1990.

Due to the lack of information relative to their specific locations and the low overall associated acreage, which per subwatershed would be minimal, disturbance acreages associated with uranium, sand, gravel, and scoria mines were not quantified for the PRB Coal Review.

2.1.4.4 Paleontological Resources

Predictions relative to potential future impacts to paleontological resources were not presented in the Coal Development Status Check (BLM 1996) or earlier coal leasing NEPA documents for the Wyoming PRB (BLM 1973, 1979, 1981, 1984).

2.2 Soils and Alluvial Valley Floors

2.2.1 Key Issues

The key issues related to soils and alluvial valley floors include:

- The maintenance of long-term soil productivity; and
- The maintenance of long-term hydrologic function of alluvial valley floors (AVFs) for the continuation of important subirrigation and flood irrigation practices for agricultural production.

2.2.2 Study Area

The baseline study area for the resources of soils and AVF includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (**Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**). In addition, the study area encompasses 18 subwatersheds (fourth order) (**Figure 1-4**).

2.2.3 Current Conditions

2.2.3.1 Soils

Soils in the PRB can be classified into three main soil orders: Entisols, Aridisols, and Mollisols. The most extensive soils are Entisols, which are recent soils occurring mainly on sloping topography where geologic erosion outpaces soil profile development or organic matter accumulation. The physical and chemical characteristics of Entisol soils largely depend on the soil parent materials and the bedrock on which they occur. These soils generally are low in plant nutrients and commonly have clay textures.

The PRB also has extensive areas of gently sloping to nearly flat, more stable, topography. Soils on these surfaces commonly are identified as Aridisols. These soils commonly have low to moderate organic matter content and plant nutrients in the surface layer. They also have moderate to strong structural development within the surface and subsoil layers. This generally means that carbonates and salts have been leached by water to depths of 1 to 2 feet, or more. This produces a more fertile rooting zone, particularly when soil textures are loamy rather than sandy or clayey.

The third and least extensive group of soils is the Mollisols. These soils are the most fertile and have higher levels of organic matter and nutrients, particularly in the surface layer. Mollisols are the best source of soil for reclaiming project disturbance.

There also are fluvial soil types in the PRB, which are found on gently sloping to flat drainage bottoms. Fluvial soils vary considerably in fertility, depending on the source of alluvium. Fluvial soils low in salts and sodium tend to be very fertile and are the most productive in the basin (BLM 1984).

Soil survey information is available, at different levels of intensity and scales of mapping, for soils in the PRB. County soil surveys have been completed and published by the Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service) for Sheridan County (Lupcho 1998), southern Johnson County (Stephens 1975), southern Campbell County (Westerman and Prink 2004), northern Campbell County (Prink et al. 2004), and northern Converse County (Reckner 1986). Soils mapping currently is being conducted for northern Johnson County but is incomplete at this time.

These county soil surveys generally are mapped at the order 3 level of intensity on a photo base at the scale of the USGS 7.5-minute topographic quadrangle maps (1 inch equals 2,000 feet). Approximately 80 or more individual soil series in the PRB have been mapped and described. The NRCS maintains current files for all of these soils, and Official Soil Series Descriptions are available on the NRCS web site.

More detailed soils information is available for the 20 major coal mine permit areas, located primarily in a line beginning north of Gillette and continuing southward to northern Converse County, as well as in the area northeast of Sheridan. The soils mapping for these coal permit areas was done at a more detailed (Order 1-2) level of intensity on photo base maps at a scale of approximately 1 inch equals 400 feet. These surveys also included substantial soil sampling for laboratory analysis and interpretation. These surveys were reviewed and approved by the Wyoming Department of Environmental Quality (WDEQ), Land Quality Division (LQD) as part of the mine permitting process.

More general soils information is available from the state soil geographic (STATSGO) database mapping for the State of Wyoming. This NRCS product is being used for this study to describe the soils of the PRB because of the basin's large size and the lack of complete coverage by the county soil surveys. STATSGO provides an all inclusive, general description of the soils of the basin, but it is too general for use in project-specific impact evaluations.

Soil associations are used in the STATSGO mapping. Each association is named for the three dominant soil series within the association. The geographic distribution of soil associations in the PRB, as well as three slope gradient categories, is presented in **Figure 2.2-1**. The slope categories are: less than 25 percent slope, between 25 and 40 percent slope, and greater than 40 percent slope. The 60 soil association map units in the PRB are listed in **Table 2.2-1**, which also includes the percent that each association occupies in the basin. Thirty-three of these map units occupy less than 1 percent each in aerial extent in the basin.

Table A-1 in Appendix A lists the dominant soil series for each STATSGO map unit, and provides general characteristics for the soils. The soils information was based on current published and unpublished NRCS surveys and includes surface texture and slope range for each soil. The slope information was used in combination with the soils information to assess areas with high potential for water erosion. **Table A-1** also identifies the soils that have severe wind and water erosion hazards, high compaction potential (based on clay type and content and high shrink swell capacity), high salinity and sodicity, poor revegetation potential, and prime or otherwise valuable agricultural soils.

SHERIDAN COUNTY

JOHNSON COUNTY

CAMPBELL COUNTY

CONVERSE COUNTY

DAYTON

SHERIDAN

BUFFALO

GILLETTE

WRIGHT

KAYCEE

Burlington Northern RR

Union Pacific RR

PP&L RR

I-90

I-25

14

16

59

387

14/16

WY124

WY125

WY126

WY127

Soils and Slopes

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

- Slope less than 25%
- Slope between 25% and 40%
- Slope greater than 40%
- Disturbed_unrecl_dissolved061005
- WY206 STATSGO soil unit ID

WYOMING

N W E S

0 5 10 15 Miles

0 5 10 15 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003

Powder River Basin Coal Review

Figure 2.2-1

Soils and Slope

2.2-3

6/20/05

Table 2.2-1
Soil Associations and Areal Extent in the Study Area

STATSGO Map Unit	Soil Association Map Unit Name	Percent of Study Area
WY002	Midway - Samday - Rock Outcrop	0.20
WY004	Haverson - Glenberg - Bone	0.46
WY042	Cabbart - Yawdim - Hesper	0.20
WY043	Ridge - Broadus - Reeder	0.05
WY044	Havre - Hanly - Glendive	0.16
WY045	Cabbart - Yawdim - Thurlow	0.49
WY046	Cabba - Ringling - Yawdim	0.55
WY047	Draknab - Arvada - Bidman	0.41
WY048	Riverwash - Haverdad - Clarkelen	2.50
WY049	Shingle - Renohill - Forkwood	8.12
WY050	Shingle - Taluce - Kishona	11.47
WY051	Wyarno - Hargreave - Moskee	0.72
WY053	Shingle - Cushman - Taluce	3.22
WY055	Haverdad - Havre - Zigweid	2.08
WY056	Samday - Shingle - Rock Outcrop	0.56
WY057	Doney - Shaak - Wayden	0.92
WY058	Abac - Peritsa - Rock Outcrop	<0.01
WY059	Rock Outcrop - Starley - Woosley	2.69
WY060	Tolman - Abac - Rock Outcrop	0.67
WY061	Agneston - Rock Outcrop - Granile	0.55
WY062	Owen Creek - Tongue River - Gateway	<0.01
WY063	Wolf - Platner - Platsher	1.48
WY064	Plashter - Recluse - Parmleed	0.99
WY065	Baux - Bauxson - Harlan	2.50
WY066	Moskee - Hargreave - Shingle	1.20
WY078	Frisco - Troutville - Teewinot	0.04
WY081	Barnum - Haverdad - Rock Outcrop	0.40
WY082	Reno - Shingle - Parmleed	8.17
WY084	Keyner - Samday - Rock Outcrop	1.93
WY085	Samday - Badland - Rock Outcrop	0.81
WY086	Cambria - Shingle - Kishona	1.44
WY087	Shingle - Cambria - Renohill	0.83
WY088	Sunup - Rock Outcrop - Spearfish	1.55
WY114	Tassel - Turnercrest - Terro	0.01
WY115	Shingle - Samday - Absted	0.21
WY124	Plashter - Kishona - Hiland	1.98
WY125	Shingle - Theedle - Wibaux	2.40
WY126	Hiland - Vonalee - Maysdorf	4.27
WY127	Kishona - Shingle - Theedle	4.10
WY128	Renohill - Cushman - Cambria	3.15
WY129	Bidman - Parmleed - Renohill	2.70
WY130	Renohill - Bidman - Ulm	6.29
WY203	Clarkelen - Draknab - Haverdad	0.25
WY204	Hiland - Ustic Torriorthents - Bowbac	1.50
WY205	Dwyer - Orpha - Hiland	0.61
WY206	Wibaux - Rock Outcrop - Shingle	1.40
WY207	Hiland - Bowbac - Tassel	3.02

Table 2.2-1 (Continued)

STATSGO Map Unit	Soil Association Map Unit Name	Percent of Study Area
WY208	Shingle - Samday - Hiland	1.53
WY209	Hiland - Shingle - Tassel	5.52
WY210	Ulm - Renohill - Shingle	1.33
WY211	Shingle - Tassel - Rock Outcrop	1.74
WY315	Rock Outcrop - Hazton - Redsun	0.20
WY316	Hiland - Bowbac - Keyner	<0.01
WY317	Shingle - Taluce - Amodac	0.10
WY321	Hiland - Orpha - Bowbac	0.08
WY322	Roughlock - Rock Outcrop - Rekop	0.08
WY323	Lolite - Hiland - Vonalee	0.01
WY324	Hiland - Forkwood - Zigweid	0.11
WY325	Lolite - Rock Outcrop - Keyner	0.06
WYW	Surface Water	0.02

Source: BLM 2003a.

Wind erosion hazard is represented by the wind erosion group number for each soil, and is based on physical characteristics including soil texture (percent sand, silt, and clay), structure, and coarse fragment content. Soils in the study area range from fine sand with severe wind erosion hazard to very wet or stony soils with only slight or no erosion hazard. Soils with severe wind erosion hazard are present from the Wyoming/Montana state line south down the center of Campbell County to approximately 14 miles south of Gillette and along the Little Powder River. They also are present in much of Converse County (BLM 2003a).

Slope hazards are dependent on slope gradient. Slopes from 0 to 25 percent are rated as minimal hazards. Slopes between 25 and 40 percent have moderate hazards, and slopes greater than 40 percent have severe hazards. For project disturbance, soils often are not recommended for salvage on slopes greater than 40 percent. In the PRB, moderate and severe slope hazards occur primarily along the southwestern corner of Johnson County and as small scattered areas throughout the basin (BLM 2003a).

Water erosion hazard is determined by several factors including organic matter content, K factor (the higher the number the higher the hazard), permeability class, and slope. Soils on slopes of 25 to 40 percent often have moderate water erosion hazards; soils on slopes greater than 40 percent have severe hazards. Severe and moderate water erosion hazard soils occur primarily along the southwestern corner of the basin in Johnson County where slopes of 25 to 40 percent and greater than 40 percent occur. Severe water erosion hazard soils also occur along the northern and eastern borders of the basin as well as down the center along the Powder River and into Converse County (BLM 2003a).

Compaction and shrink/swell potential are related to the amount and type of clay in a soil and affect the soil's ability to support construction and be reclaimed. In soils with a high shrink/swell potential, rapid changes in volume can damage structures and roads. Soils with 35 percent or greater clay content are classified as high clay. Soils with montmorillonite (smectite or bentonite) clays are considered to have a high shrink/swell potential. Soils with severe shrink/swell potential occur along the northern and western borders of the basin, on both sides of the Powder River, down the center of Sheridan and Johnson counties, in the eastern portion and entire southern half of Campbell County, and in small scattered areas of Converse County (BLM 2003a).

Soil salinity and sodicity are measured by electrical conductivity (EC) and sodium adsorption ratio (SAR), respectively. Salinity impacts a plant's ability to take in water, whereas sodicity slows the movement of water through the soil. Soils with an EC of 0 to 8 are considered slightly saline, soils with an EC from 8 to 16 are considered moderately saline, and soils with an EC greater than 16 are strongly saline. Soils with an SAR greater than 15 are considered sodic. Approximately 40 percent of the soils in the PRB are considered saline and/or sodic. Saline soils are located near the confluence of the Powder River and the South Fork of the Powder River and along the Belle Fourche River, Black Thunder Creek, and Little Black Thunder Creek (BLM 2003a).

Soils with poor revegetation potential are identified by two methods. The first method uses the land capability classification contained in the county soil surveys. Soils are given a number between one and eight depending on limitations for agriculture and response to management. Classes VII and VIII were determined to have poor revegetation potential for reclamation of disturbances associated with energy development projects. Soils with poor revegetation potential are located throughout the PRB except in the central portion of Campbell County (BLM 2003a).

The second method for evaluating reclamation/revegetation potential uses site-specific soil sampling and description, laboratory analysis of soil samples, and a subsequent suitability evaluation and salvage depth recommendation (WDEQ 1994). This method is appropriate for project-specific land areas and usually requires the completion of a detailed (Order 1-2) soil survey.

Prime agricultural soils in the PRB were determined by the NRCS State Office in Casper, Wyoming. Portions of Sheridan County, Converse County, and the central portion of Campbell County contain prime agricultural soils. These soils also extend into Johnson County along the Powder River and Clear Creek (BLM 2003a).

Based on GIS analysis, as of the end of 2003, the existing development-related soil disturbance in the PRB study area was approximately 121,890 acres, of which approximately 51,107 acres of disturbance was related to coal mining activity (see **Table 2.2-2**). The primary soil associations impacted as a result of coal mine development have included the Renohill – Bidman – Ulm, Hiland – Vonalee – Maysdorf, Kishona – Shingle – Theedle, Bidman – Parmleed – Renohill, Wibaux – Rock Outcrop – Shingle, Shingle – Tassel – Rock Outcrop, and Haverson – Glenberg – Bone.

Table 2.2-2
Existing Soil Disturbance in the PRB Study Area[1]

Subwatershed	Total Disturbance[2]	Coal Mine-related Disturbance
Antelope Creek	19,807	13,785
Clear Creek	4,405	0
Crazy Woman Creek	494	0
Dry Fork Cheyenne River	1,684	0
Lightning Creek	2,900	0
Little Bighorn River	64	0
Little Missouri River	163	0
Little Powder River	17,896	8,018
Middle North Platte River	561	0
Middle Powder River	2,297	0
Middle Fork Powder River	259	0
North Fork Powder River	0	0
Salt Creek	1,225	0
South Fork Powder River	313	0
Upper Belle Fourche River	37,148	15,578
Upper Cheyenne River	16,656	13,726
Upper Powder River	12,444	0
Upper Tongue River	3,574	0
Total	**121,890**	**51,107**

[1]Based on GIS analysis of existing development-related disturbance as of end 2003.
[2]Inclusive of coal mine-related disturbance.

Source: ENSR 2005b.

2.2.3.2 Alluvial Valley Floor

The Federal Office of Surface Mining (OSM) 1977 Surface Mining Control and Reclamation Act (SMCRA) regulations define AVFs as unconsolidated stream-laid deposits where water availability is sufficient for subirrigation or flood irrigation agricultural activities (Public Law 95-87). The WDEQ administers these AVF regulations for coal mining activities in Wyoming. Before leasing and mining can proceed, AVFs must be determined, because their presence can restrict mining activities. Coal mine-related impacts to designated AVFs generally are not permitted if the AVF is determined to be significant to agriculture. Conversely, if the AVF is determined not to be significant to agriculture, or if the permit to affect the AVF was issued prior to the effective SMCRA date, the AVF can be disturbed during mining but must be restored during reclamation.

WDEQ/LQD determines significance to agriculture based on specific calculations related to the production of crops or forage on the AVF and the size of the existing agricultural activities on the land of which the AVF is part. In addition, for any designated AVF, regardless of its significance to agriculture, it must be demonstrated that the essential hydrologic functions of the valley would be protected.

The determination of AVFs is done in accordance with the OSM and WDEQ/LQD guidelines that require detailed studies of soils, geomorphology, hydrology, vegetation, and land use. Three items must be determined as limiting criteria: 1) the possibility for artificial flood irrigation, 2) past and/or present flood irrigation, and 3) apparent subirrigated areas and the possibility for natural flood irrigation. Areas that meet these criteria are then studied for their practical use for agriculture.

The following information summarizes the current conditions for AVFs within the coal mining areas in the Wyoming PRB. Essential hydrologic functions and their restoration are not part of this discussion.

The coal mines have been grouped into four areas based on geographic distribution within the basin including: 1) Subregion 1, those mines near Gillette and extending to the north; 2) Subregion 2, mines south of Gillette and north of Wright; 3) Subregion 3, mines east of Wright and extending to the south into the northern part of Converse County; and 4) Subregion 4, former mines northeast of Sheridan to the Wyoming/Montana state line (see **Figure 1-1**).

AVF information obtained from various NEPA documents as well as the State Decision Documents (SDDs) prepared for each mine by the WDEQ/LQD with their attendant permit numbers is presented below. Recently issued LBAs and pending LBAs are considered future actions and are not considered part of current conditions.

Subregion 1

The Subregion 1 area includes the Buckskin, Dry Fork Mine, Eagle Butte Mine, Rawhide Mine, and Wyodak Mine. AVF areas were identified on the Buckskin Mine, Eagle Butte Mine, (former Fort Union Mine [now part of Dry Fork]), and Rawhide Mine permit areas. AVFs were not identified on the Hay Creek Amendment Area of the Buckskin Mine, or on the Wyodak Mine permit area. AVF information was not available for the Dry Fork Mine. Mine plan and reclamation features to prevent

long-term impacts and the maintenance of essential hydrologic functions for declared AVF areas are contained in various sections of each mine's permit document.

Buckskin Mine Including Hay Creek Amendment (SDD, Permit 500-T6-A1, Change No. 4). Declared AVF areas were identified along Rawhide Creek and Spring Draw, and are shown on Map D11-1 of the Buckskin Mine permit. Previous disturbance to the Rawhide Creek AVF is delineated on Map D11-2 of the Buckskin permit. AVF areas were identified along Rawhide Creek and lower Spring Draw, with disturbance proposed along portions of the Rawhide Creek AVF. The entire Spring Draw AVF within the permit area will be mined out. Neither of these AVF areas were determined to be significant to farming, and no AVF was identified in association with the Hay Creek Amendment. At the end of the third permit term (T3), all identified AVFs proposed to be disturbed were disturbed. Reconstruction work has been completed on the Rawhide Creek AVF, and natural flow was returned to the channel in year 2000. Work on the Little Draw AVF and the Spring Draw AVF replacement feature was completed in year 2001 at the confluence of Little Draw and Rawhide Creek. Reclamation work on the Little Draw AVF (the Spring Draw AVF replacement feature) was completed in 2001 at the confluence of Little Draw and Rawhide Creek.

Eagle Butte Mine Including the Eagle Butte LBA (SDD, Permit No. 428-T4-A1, Change No. 13, and Final Eagle Butte EA [BLM 1994]). Much of Little Rawhide Creek has been declared an AVF non-significant to farming as it diagonally traverses the northern part of the permit area from west to east. Other portions of Little Rawhide Creek and its tributaries coming from the south within and adjacent to the permit area also have been declared AVF. AVF declarations are documented in Section 2.10 and Appendix 2.10-4 of the Eagle Butte mine permit. Monitoring, mitigation, and reclamation plans are presented in Subsections 3.5.8.7, 4.6.1, and 4.6.2 of the permit and are designed to prevent material damage to water supplies for the declared AVF. Reclamation features to prevent long-term impacts and to restore essential hydrologic functions to AVF areas adjacent to mining operations appear in Subsection 4.6.2.4 of the permit.

Former Fort Union Mine (now part of Dry Fork) (SDD, Permit No. 659-T2). The Fort Union Mine currently is subject to a Temporary Cessation of Operations. The Dry Fork of the Little Powder River is an AVF not significant to agriculture from a southwest point 1,320 feet south of the northwest corner of T50N, R72W, Section 1 to a point at least 660 feet southwest of its confluence with the Little Powder River in T51N, R71W, Section 6. Only a very short reach of the AVF is located within the permit area. The permit application describes how the essential hydrologic functions will be adequately restored for the AVF if it is mined through in the future.

Rawhide Mine (SDD, Permit No. 240-T4-R4, Change No. 6). AVFs were identified in four locations within the permit area: 1) the Dry Fork Little Powder River; 2) the Little Rawhide Creek north of the section line between T51N, R73W, Sections 4 and 9; 3) Rawhide Creek downstream from the Buckskin Mine eastern permit boundary; and 4) Rawhide Creek in T51N, R72W, Section 6 from U.S. Highway 14/16 to the Buckskin Mine access road. Both upper Rawhide Creek and Little Rawhide Creek will be mined through during life-of-mine operations. As a result of revision during the third permit (T3) term, Rawhide Creek will not be mined through near its confluence with Little Rawhide Creek. In addition, the lower reaches of Little Rawhide Creek will not be mined near its confluence with Rawhide Creek.

The significance to farming has been "grandfathered" for the AVFs within the Rawhide Mine permit area. Caballo Coal Company is allowed to mine the AVFs but is required to restore the essential hydrologic functions associated with the AVFs that are disturbed.

Wyodak Mine (SDD, Permit No. 232-T5). The Wyodak Mine permit area is adjacent to an AVF on a portion of Donkey Creek located east of the permit area in the north one-half of T50N, R71W, Sections 26 and 27. The AVF begins about 0.25 mile east of the permit boundary, and extends to at least 0.5 mile into Section 26 downstream of the permit area. No other drainages within or adjacent to the permit area contain AVFs.

The significance to farming has been "grandfathered" for any AVFs within the Wyodak Mine permit area. The AVF on Donkey Creek is not projected to be disturbed. However, should it be affected, Wyodak would be required to restore all essential hydrologic functions associated with the Donkey Creek AVF.

Subregion 2

The Subregion 2 area includes the Belle Ayr, Caballo, Cordero-Rojo, and Coal Creek mines. AVFs were identified on the Belle Ayr and Caballo mines and on the Caballo Rojo portion of the Cordero-Rojo Mine. No AVFs were identified on the Cordero portion of the Cordero-Rojo Mine, or on the Coal Creek Mine permit area.

Belle Ayr Mine (SDD, Permit 214-T6). Two areas along Caballo Creek were designated as AVFs, although no specific determinations were made regarding significance to farming. Belle Ayr contended that unsuitable soils and water quality rendered the areas insignificant to farming. More recent information included new potential AVF areas on Bone Pile, Caballo, and Duck Nest creeks within the 214-T4 permit boundary. WDEQ has concluded, however, that no significant areas of AVFs exist within the Belle Ayr permit area. There is an area of 134 acres to the east of active mining that historically has been used as subirrigated hayland. However, the high groundwater levels in the alluvium in this area are artificially sustained by stock dams in the Caballo Creek channel and thus do not meet the natural subirrigation criterion of WDEQ guidelines.

Caballo Mine (SDD, Permit 433-T1 and T-5). There are two major alluvial systems within the Caballo Mine permit area; however, neither area will be mined under existing permits. The confluence area where Tisdale, North Tisdale, and Gold Mine draw converge has been designated as an AVF. The AVF in Gold Mine Draw in T48N, R71W, Sections 13 and 24 is considered significant to farming. Existing disturbance in this area is confined to a railroad loop and sedimentation pond. Both of these structures, "grandfathered" under a previous state permit, will be removed at the end of mining. The long-term impacts to this AVF are expected to be minimal once reclamation is complete.

Cordero-Rojo Mine (Caballo Rojo SDD, Permit No. 511-T6-R1-Change No. 2, and Cordero SDD, Permit No. 237-T6). The Caballo Rojo Mine and the Cordero Mine previously were combined into the Cordero-Rojo Mine. The individual permits for the two mines have not yet been integrated into one permit document. No AVFs exist within the Caballo Rojo permit area. Two AVFs do exist, however, along Caballo Creek to the north of the Caballo Rojo permit area. These AVFs, known as the western and eastern Caballo Creek AVFs, are located within and adjacent to the Belle Ayr Mine. The potential effects of mining within the Caballo Rojo permit area on these somewhat distant

AVFs are discussed in the Caballo Rojo Mine Plan, and are expected to be mitigated. For the Cordero permit area, no AVFs have been identified. The valleys of Kicken and Bengal Draws, Coal Creek, and the Belle Fourche River in the vicinity of the Cordero Mine are not AVFs, because they are not capable of supporting subirrigation or flood irrigation agricultural activities.

Subregion 3

The Subregion 3 area includes the Antelope, Black Thunder, Izita, Jacobs Ranch, North Antelope/Rochelle, and North Rochelle mines. AVFs were identified on mines in Subregion 3 including the Antelope, Black Thunder, Jacobs Ranch, and the North Antelope/Rochelle mines. No AVFs were identified on the North Rochelle Mine. The former Dave Johnston Mine (Glenrock Coal), currently in final reclamation, is located to the southwest of Subregion 3. No AVFs were identified on this mine.

Antelope Mine (SDD, Permit 525-T7). An area along Antelope Creek originally was designated an AVF. The area subsequently was refined to include only those areas which are delineated as "Possible Subirrigated AVF of Minor Importance to Agriculture." An additional AVF along Horse Creek was designated and contained 61.2 acres, with 50.6 acres permitted to be disturbed by mining. The approved reclamation for this area will require replacement of the alluvial materials and restoration of the hydrologic function of the AVF.

Black Thunder Mine (SDD, Permit No. 233-T6). AVFs within the original State Program Permit area are "grandfathered," because the mine was sited prior to the passage of SMCRA in 1977. AVFs disturbed by mining will be restored to their hydrologic functions. There is a large confluence area between the North Prong of Little Thunder and Little Thunder Creek immediately adjacent to the eastern permit boundary. Future mining is not expected to materially damage the quantity or water supply of the AVFs. Those AVFs that exist off site, outside the permit boundary, will not be mined, and the operation is not expected to materially damage the quantity of water supplying them. A recent change, approved by WDEQ, removed the AVF assessment for the North Prong of the Little Thunder Creek.

Izita Mine (SDD, Permit No. 676-T1). Thunder Basin Coal Company received a regular mining permit for an area that would serve as an equipment transportation corridor between its Black Thunder Mine (Permit No. 233) and Coal Creek Mine (Permit No. 483), a distance of approximately 23 miles. Because no surface mining is authorized under this permit, WDEQ/LQD did not require a formal AVF study and did not make a formal declaration

Jacobs Ranch Mine (SDD, Permit No. 271-T4-R2). A designated AVF exists within the permit area in T43N, R70W, Sections 22 and 23. Appendix D-11 of the Jacobs Ranch permit describes the AVFs within and adjacent to the permit area. The AVF is "grandfathered" with regard to significance to farming. The mine will not materially damage the quality or quantity of surface or subsurface waters which supply the North Prong or Little Thunder Creek.

North Antelope/Rochelle Mine (SDD, Permit No. 569-T5-A2, Change 28). Four AVF studies have been completed on the North Antelope/Rochelle Mine Complex permit area over time including: 1) the Rochelle Mine, Permit No. 569-T1; 2) the North Antelope Mine, Permit No. 532-T1; 3) the North Antelope 1995 amendment, Permit No. 532-T5; and 4) the North Antelope/Rochelle Mine Complex amendment, Permit No. 569-T5.

WDEQ/LQD determined that an AVF did not exist in the original Rochelle Mine permit area. They determined that a 622-acre AVF did exist within the original North Antelope Mine permit area based on the presence of unconsolidated streamlaid deposits and presumably enough water to potentially flood irrigate these deposits. This AVF was determined not to be significant to farming. North Antelope's T-5 permit amendment area was determined not to contain an AVF due to the presence of an incised channel, limited availability of water due to the relatively flat topography, and relatively narrow cross sectional area which would be inundated by the predicted peakflow for the 2-year event. The North Antelope/Rochelle Mine Complex amendment area was determined not to contain an AVF because of the incised channel morphology and minimal extent of streamlaid deposits.

Dave Johnston Mine (SDD, Permit No. 291-T6). Coal mining was completed at the Dave Johnston Mine on September 28, 2000, and the mine currently is in final reclamation. An AVF located along a portion of Sage Creek occurs approximately 3.5 miles east of the permit area. No mining activities took place within the Sage Creek watershed, and, therefore, there were no surface water impacts. However, groundwater impacts may be induced by mining geologic units supplying discharge to the AVF.

Subregion 4

The Subregion 4 area, in the northwest portion of the Wyoming PRB, contains the former Public Service Company of Oklahoma (PSO) Ash Creek, Big Horn Coal, and Welch No. 1 North mines. None of these mines currently are active. The Ash Creek Mine currently is in field reclamation, and the Big Horn Mine is in final reclamation. The Welch No. 1 Mine was never developed beyond a small test pit. All of these mines contained AVFs.

PSO Ash Creek Mine (SDD, Permit No. 407-T1). Within the former PSO Ash Creek Mine permit area, one AVF was identified along Little Youngs Creek. The AVF extends across the northeastern portion of the permit boundary and across adjacent areas 0.5 mile upstream and downstream of the permit area. There are approximately 54 acres of streamlaid deposits underlying the channel, floodplain, and terraces of Little Youngs Creek. The areal extent of the alluvial gravel aquifer is approximately 66 acres. This 66-acre areal extent of potentially irrigable farmland will be restored during reclamation in accordance with permit requirements. The AVF is "grandfathered" in regard to significance to farming.

Big Horn Mine (SDD, Permit No. 213-T5). AVFs are present within the former mine's permit area, and are described on page MP-14 of the Mine Plan. Appendix D-11 of the permit application contains a detailed discussion of the location and characteristics of these AVFs. Portions of the alluvial systems in T57N, R84W, Sections 13 and 14 were projected to be disturbed by the Pit 3 mine plan. The permanent loss of the AVF area was addressed in the Reclamation Hydrology section of the Reclamation Plan.

Welch No. 1 North Mine (SDD, Permit No. 497-T3). There was a pre-application determination that an AVF significant to farming was present within and adjacent to the historic permit boundary. Addendum 2.11-A contains the WDEQ/LQD Administrator's June 17, 1985, pre-application determination. The associated Figure 2.11-A shows the "AVF Significant to Farming as Determined on 5-25-85." The permit boundary subsequently was reduced, resulting in the majority of the AVF residing adjacent to and outside the T3 permit area boundary.

The T3 permit has no approved Mine Plan. The Reclamation Plan details permanent reclamation or stabilization of the approximately 10 acres of surface disturbance that occurred outside of the AVF area. None of the reclamation activities have the potential to detrimentally affect the AVF within or adjacent to the permit area boundary.

2.2.4 Comparison to Previous Predictions

Soils within the study area have been disturbed by various development activities associated with coal mines, other mines, power plants, transmission lines, pipelines, reservoirs, coal technology plants, railroads, CBNG, and conventional oil and gas. Reclamation has been completed within some of these disturbance areas, thereby reducing the overall level of long-term disturbance to soils.

Predictions made in earlier EISs (BLM 1979, 1981) for development-related disturbance and reclamation activities in the PRB were compared in the Coal Development Status Check (BLM 1996) to actual 1990 and 1994 disturbance and reclamation data. Based on the data in the 1996 document, actual disturbance and reclamation acreages affecting soils in 1994 were 73,321 and 21,964, respectively. In comparison, the existing disturbance acreage affecting soils at the end of 2003 (based on GIS analysis) was 121,890 (ENSR 2005b). Based on the Task 2 database, at the end of 2003, a total of approximately 136,284 acres of previously disturbed land had been reclaimed (ENSR 2005a). Information relative to disturbance and reclamation of AVFs was not presented in these earlier documents.

2.3 Vegetation Including Wetlands and Riparian Areas

2.3.1 Key Issues

Key issues for vegetation resources include:

- Temporary and permanent loss of vegetation;
- Displacement of native vegetation by noxious and invasive plant species as a result of surface disturbance;
- Potential long-term loss of wetlands and riparian areas as a result of groundwater drawdown; and
- Potential decrease in floristic diversity within wetland and riparian areas in the long-term as a result of increased soil salinity related to the discharge of groundwater to drainages.

2.3.2 Study Area

The study area for vegetation (including wetlands and riparian areas) includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (**Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**). In addition, the study area encompasses 18 subwatersheds (fourth order) (**Figure 1-4**).

2.3.3 Current Conditions

The PRB study area is characterized as a mosaic of general vegetation types, which include prairie grasslands, shrublands, forested areas, and riparian areas. These broad categories often represent several vegetation types that are similar in terms of dominant species and ecological importance. Wyoming Game and Fish Department (WGFD) land cover classifications mapping and Gap Analysis Project (GAP) resources generated by the USGS Biological Resources Division were used to identify specific vegetation types within the PRB study area. Fourteen vegetation types were identified, of which ten primarily consist of native vegetation and are collectively classified as rangeland. These vegetation types include short-grass prairie, mixed-grass prairie, sagebrush shrubland, other shrubland, coniferous forest, aspen, forested riparian, shrubby riparian, herbaceous riparian, and wet meadow. The remaining vegetation types support limited or non-native vegetation and include cropland, urban/disturbed, barren, and open water.

2.3.3.1 General Vegetation

Figure 2.3-1 illustrates the vegetation types within the PRB study area and primarily was derived from detailed WGFD land cover classifications mapping data and GAP data. **Table 2.3-1** provides the approximate acreages of pre-disturbance vegetation types present within the PRB study area by subwatersheds. **Tables 2.3-2** and **2.3-3** provide approximate total existing disturbance acreages of vegetation types from past and present development and approximate existing coal mine-related disturbance of vegetation types, respectively, within the subwatersheds in the PRB study area.

SHERIDAN COUNTY

JOHNSON COUNTY

CAMPBELL COUNTY

CONVERSE COUNTY

DAYTON

SHERIDAN

BUFFALO

GILLETTE

WRIGHT

KAYCEE

Burlington Northern RR

Union Pacific RR

PP&L RR

I-90

I-25

14

14/16

16

59

387

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

Vegetation

- Agriculture
- Aspen
- Barren
- Coniferous Forest
- Forested Riparian
- Herbaceous Riparian
- Other Shrublands
- Sagebrush Shrublands
- Short & Mixed Grass Prairie
- Shrubby Riparian
- Urban/Disturbed
- Water
- Wet Meadow

WYOMING

N W E S

0 5 10 15 Miles

0 5 10 15 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003

Powder River Basin Coal Review

Figure 2.3-1

Vegetation Communities

6/20/05

Table 2.3-1
Pre-disturbance Vegetation Types by Subwatershed
(acres)

Subwatershed	Cropland	Aspen	Barren	Coniferous Forest	Forest Riparian	Herbaceous Riparian	Mixed-grass Prairie	Other Shrubland	Sagebrush Shrubland	Short-grass Prairie	Shrubby Riparian	Urban/ Disturbed	Open Water	Wet Meadow	Total
Little Bighorn River	683	0	0	4,497	601	0	22,088	190	4,331	1,093	10,607	0	44	5,450	49,584
Upper Tongue River	59,054	12	4,121	15,268	3,172	67	303,681	538	119,743	124,204	32,931	0	1,106	75,985	739,883
Middle Fork Powder River	584	3	16,300	50,714	1,767	5	107,780	106,068	61,800	117,613	173	0	202	1,441	464,450
North Fork Powder River	0	0	0	3,060	1,628	0	8,583	643	4,788	109	0	0	0	1,864	20,674
Upper Powder River	5,958	0	25,154	6,715	0	0	108,273	13	424,945	1,020,637	582	0	1,385	9,857	1,603,52
South Fork Powder River	1	0	1,803	2,545	48	0	24,744	30,090	12,255	42,727	0	0	145	0	114,355
Salt Creek	0	0	186	3,562	0	0	3,892	779	42,588	101,205	0	0	148	0	152,360
Crazy Woman Creek	8,567	56	9,114	33,127	636	46	112,690	15,892	124,132	237,516	1,059	0	426	5,021	548,283
Clear Creek	27,184	0	4,754	11,510	1,033	41	170,380	1,799	128,218	156,872	9,347	0	3,607	32,732	547,476
Middle Powder River	1,143	0	3,265	10,636	0	0	72,552	0	47,363	81,888	547	0	0	6,835	224,230
Little Powder River	998	0	9,447	26,102	0	0	172,184	0	375,460	267,547	1,750	0	636	11,359	865,482
Little Missouri River	320	0	144	567	0	0	20,842	0	7,175	5,853	550	0	0	3,078	38,528
Antelope Creek	398	0	5,095	6,750	948	0	15,336	387	124,618	506,336	0	0	430	0	660,298
Dry Fork Cheyenne River	795	0	8,827	9,040	1,518	5,198	105,618	1,340	58,898	116,898	771	384	29	0	309,316
Upper Cheyenne River	108	0	2,771	4,477	141	114	6,147	0	87,729	104,629	169	0	419	99	206,803
Lightning Creek	7,085	0	2,093	0	0	4,263	95,124	20,143	166,207	11,710	0	1,698	0	0	308,321
Upper Belle Fourche River	764	0	18,302	3,355	0	0	85,962	0	353,206	377,016	432	0	612	5,215	844,863
Middle North Platte	0	0	4,147	260	0	2,604	112,635	0	90,647	0	0	2,280	0	0	212,573
Total	**113,643**	**71**	**115,524**	**192,184**	**11,491**	**12,337**	**1,548,511**	**177,880**	**2,234,103**	**3,273,850**	**58,917**	**4,362**	**9,189**	**158,937**	**7,911,00**

Source: BLM 2003a.

Table 2.3-2
Total Existing Vegetation Disturbance from Development by Subwatershed[1]
(acres)

Sub-watershed	Cropland	Aspen	Barren	Coniferous Forest	Forest Riparian	Herbaceous Riparian	Mixed-grass and Short-grass Prairie[2]	Other Shrublands	Sagebrush Shrublands	Shrubby Riparian	Urban /Disturbed	Open Water	Wet Meadow	Total
Little Bighorn River	1	0	0	0	0	0	54	0	4	5	0	0	<1	64
Upper Tongue River	298	0	75	12	2	0	1,906	0	732	117	0	11	421	3,574
Middle Fork Powder River	0	0	16	0	2	0	192	35	14	0	0	0	0	259
North Fork Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	94	0	167	24	0	0	8,164	<1	3,745	4	0	5	241	12,444
South Fork Powder River	0	0	3	42	0	0	160	54	54	0	0	0	0	313
Salt Creek	0	0	1	19	0	0	1,003	7	195	0	0	0	0	1,225
Crazy Woman Creek	39	0	4	0	<1	0	367	27	47	<1	0	0	10	494
Clear Creek	193	0	13	3	<1	0	1,620	0	607	41	0	1,552	376	4,405
Middle Powder River	23	0	33	35	0	0	1,566	0	522	7	0	0	111	2,297
Little Powder River	31	0	433	147	0	0	9,017	0	7,740	168	0	123	237	17,896
Little Missouri River	3	0	0	1	0	0	119	0	21	1	0	0	18	163
Antelope Creek	5	0	241	127	7	0	16,463	0	2,838	0	0	126	0	19,807
Dry Fork Cheyenne River	5	0	65	4	0	25	1,043	11	522	3	6	0	0	1,684
Upper Cheyenne River	6	0	135	123	2	3	8,772	0	7,551	2	0	58	4	16,656
Lightning Creek	38	0	8	0	0	37	898	119	1,800	0	<1	0	0	2,900
Upper Belle Fourche River	14	0	1,440	47	0	0	19,120	0	16,107	56	0	180	184	37,148
Middle North Platte River	0	0	0	0	0	6	271	0	271	0	13	0	0	561
Total	**750**	**0**	**2,634**	**584**	**13**	**71**	**70,735**	**253**	**42,770**	**404**	**19**	**2,055**	**1,602**	**121,890**

[1]GIS analysis of development-related vegetation disturbance through 2003 (inclusive of coal mine-related disturbance).
[2]The GIS files do not distinguish between mixed-grass and short-grass prairie communities; they are combined.

Source: ENSR 2005b.

Table 2.3-3
Total Existing Vegetation Disturbance from Coal Mine Development by Subwatershed
(acres)

Sub-watershed	Cropland	Aspen	Barren	Coniferous Forest	Forest Riparian	Herbaceous Riparian	Mixed-grass and Short-grass Prairie[1]	Other Shrublands	Sagebrush Shrublands	Shrubby Riparian	Urban /Disturbed	Open Water	Wet Meadow	Total
Little Bighorn River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Tongue River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Middle Fork Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Fork Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Fork Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salt Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crazy Woman Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clear Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Middle Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Powder River	12	0	346	58	0	0	3,717	0	3,537	164	0	118	66	8,018
Little Missouri River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antelope Creek	0	0	203	101	0	0	11,526	0	1,831	0	0	124	0	13,785
Dry Fork Cheyenne River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Cheyenne River	0	0	93	114	0	0	7,249	0	6,216	0	0	54	0	13,726
Lightning Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Belle Fourche River	0	0	1,036	26	0	0	6,625	0	7,629	48	0	175	39	15,578
Middle North Platte River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**12**	**0**	**1,678**	**299**	**0**	**0**	**29,117**	**0**	**19,213**	**212**	**0**	**471**	**105**	**51,107**

[1]The GIS files do not distinguish between mixed-grass and short-grass prairies; they are combined.

Source: ENSR 2005b.

Short-grass Prairie

The short-grass prairie vegetation community accounted for 41 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community represents very sparse, sparse, and thin dry herbaceous rangeland types, as defined by the WGFD. Short-grass prairie occurs on drought-prone, mildly alkaline, medium- and fine-textured soils. Few shrubs grow consistently in short-grass prairie, because the soils are too dry and compacted to support them. Precipitation is an important determinant of the composition of plant species in grasslands. Average annual precipitation for short-grass prairie is between 10 and 16 inches per year (Colorado Natural Areas Program 1998). In Wyoming, short-grass prairie occurs primarily in the southeastern portion of the state and southward into Colorado. Within the PRB study area, short-grass prairie areas are most common in the south, occurring as the dominant vegetation community from the southern foothills of the Big Horn Mountains to the eastern PRB study area boundary. The two dominant plant species are blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*). Other plant species common to the short-grass prairie include western wheatgrass (*Pascopyrum smithii*), sand dropseed (*Sporobolus cryptandrus*), needle-and-thread (*Stipa comata*), scarlet globemallow (*Sphaeralcea coccinea*), and four-wing saltbush (*Atriplex canescens*).

Mixed-grass Prairie

The mixed-grass prairie vegetation community accounted for 20 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community is a combination of low, medium, and high herbaceous rangeland types, as defined by WGFD. Low, medium, and high refer to the chlorophyll content of the vegetation, as determined by remote sensing that was used to generate the vegetation type maps. The measure of chlorophyll content provides a rough approximation of the density of the vegetation. Mixed-grass prairie can be divided into several types and is characterized by several common species including needle-and-thread, western wheatgrass, blue grama, prickly pear cactus (*Opuntia* spp.), and scarlet globemallow. Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*) is a common shrub of this grass community in the PRB (Knight 1994). Within the PRB study area, mixed-grass prairie areas are most common along the eastern foothills of the Big Horn Mountains and sporadically occur throughout much of the northern and central portions of the PRB study area.

Sagebrush Shrubland

The sagebrush shrubland vegetation community accounted for 28 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community includes a combination of sparse, moderately dense, and dense Wyoming big sagebrush crown closure with a variety of understory grasses and forbs. The sagebrush shrubland is widely distributed and occupies a large proportion of the PRB study area. Plant species that typically occur in this vegetation type may include Wyoming big sagebrush, silver sagebrush (*Artemisia cana*), western wheatgrass, junegrass (*Koeleria macrantha*), needle-and-thread grass, Sandberg bluegrass (*Poa secunda*), prickly pear cactus, scarlet globemallow, and rabbitbrush (*Chrysothamnus* spp.). Sagebrush shrublands occur throughout the entire PRB study area, with the Big Horn Mountains and associated foothills as the only exceptions. Larger, more contiguous tracts of sagebrush occur in the northeastern, central, and eastern portions of the PRB study area.

Other Shrubland

The other shrubland vegetation type accounted for 2 percent of the pre-disturbance vegetation in the PRB study area. This vegetation type is composed of three distinct shrub-dominate plant communities: mountain-mahogany shrubland, mixed foothill shrubland, and greasewood shrubland. The mountain-mahogany shrubland community is the largest component of the other shrubland vegetation type and has two species-dominated sub-classes. The first community occurs primarily in the foothills of the Big Horn Mountains in southwestern Johnson County and is dominated by curl-leaf mountain mahogany (*Cercocarpus ledifolius*). The second community, occurring in the southern portion of the PRB study area, is dominated by true mountain-mahogany (*Cercocarpus montanus*). The two mountain-mahogany shrubland communities occur on poorly developed soils derived from sandstone, limestone, and shale (Knight 1994). Plant species found in the undergrowth of this community include fringed sage (*Artemisia frigida*), sulfurflower buckwheat (*Eriogonum umbellatum*), bluebunch wheatgrass (*Elymus spicatum*), and junegrass.

The other two components of the other shrubland vegetation type are intermingled among the mountain-mahogany communities. The mixed foothill shrubland community is dominated by mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*) interspersed with antelope bitterbrush (*Purshia tridentata*), serviceberry (*Amelanchier alnifolia*), skunkbush sumac (*Rhus trilobata*), common chokecherry (*Prunus virginiana*), and snowberry (*Symphoricarpos* spp.). Common forbs and grasses found in the mixed foothill shrubland may include lupine (*Lupinus* spp.), arrowleaf balsamroot (*Balsamorhiza sagittata*), hairy goldenaster (*Heterotheca villosa*), basin wildrye (*Elymus cinereus*), and junegrass. The greasewood shrubland community, dominated by greasewood (*Sarcobatus vermiculatus*), exhibits limited distribution on saline soils near seeps or perched water tables.

Coniferous Forest

The coniferous forest vegetation community accounted for 2 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community, as defined by WGFD, includes Engelmann spruce (*Picea engelmannii*), Douglas fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta* var. *latifolia*), ponderosa pine (*Pinus ponderosa*), limber pine (*Pinus flexilis*), and juniper (*Juniperus* spp.). These species tend to form associations based on elevation, exposure, and soil moisture. Typically, these species are segregated according to elevation. Juniper and pine forests tend to be lower in elevation, while spruce and fir forests occur at higher elevations. This vegetation community occurs primarily along the western edge of the PRB study area, where the upper-elevation conifer species are more common and in the northeastern corner where the lower elevation species are more common.

Aspen

The aspen vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the PRB study area. Aspen communities typically occur in depressions, ravines, valley bottoms, or on the lee sides of ridges. Aspen seedlings are intolerant of drier conditions, and, therefore, this community distribution typically is dictated by the availability of soil moisture. The understory of the aspen vegetation community has greater productivity and species diversity than any other forested upland vegetation type in the PRB study area (Mueggler 1985). Quaking aspen (*Populus tremuloides*) is the dominant species in the aspen vegetation community. Common plant

species in aspen stands include common snowberry (*Symphoricarpos albus*), serviceberry, Woods' rose (*Rosa woodsii*), western yarrow (*Achillea millefolium* var. *lanulosa*), wild geranium (*Geranium* spp.), mountain brome (*Bromus marginatus*), and elk sedge (*Carex geyeri*). Many stands of aspen are a seral (i.e., transitional) community that would have conifers of various ages growing within them. In the PRB study area, this vegetation type is limited to the Big Horn Mountains.

Cropland

The agricultural vegetation type accounted for 1 percent of the vegetation cover in the PRB study area. This land cover type is defined as croplands that are plowed or planted. These areas also may include wooded or shrubby draws and riparian areas. Agricultural areas are most common along the eastern edge of the Big Horn Mountains, along the major drainages, and near Wright and Gillette.

Urban/Disturbed

The urban/disturbed category accounted for less than 1 percent of the surface area in the PRB study area. This category includes lands covered by homes, businesses, streets, and a portion of the unvegetated surface mining areas present in the PRB. It is most common around cities and towns and along the eastern edge of the PRB study area where many coal mines are located. A detailed description of the areas disturbed by surface mining is included below in the Existing Disturbance subsection.

Barren

The barren category accounted for 1 percent of the surface area in the PRB study area. This cover type includes rock outcrops, roads, sandbars, eroded gullies, and areas with less than 10 percent ground cover and perennial snow and ice areas, as defined by WGFD. It occurs as small, scattered areas throughout the PRB study area, and as several large blocks in the southwest portion.

Open Water

The water category accounted for less than 1 percent of the surface area in the PRB study area. This category includes lakes, ponds, streams, and open water in wetlands, as defined by WGFD, and is scattered throughout the PRB study area.

Existing Disturbance

Because of past and present human activities in the PRB study area, substantial areas of vegetation have been altered from their natural condition. The primary sources of surface disturbance to vegetation types have resulted from: oil and gas development; coal mining; uranium, sand, gravel, and scoria mining; ranching; agriculture; road and railroad construction; and rural and urban housing and business development. Some of these alterations are included in the previous discussion of vegetation types, particularly in the agriculture, urban/disturbed, and barren land cover types. The total of existing disturbance acreage (as of end 2003) in each vegetation type by subwatershed have been estimated based on the past and present development activities defined in the Task 2 Report for the PRB Coal Review (ENSR 2005) (**Table 2.3-2**). Coal mine-related vegetation disturbance by subwatershed is presented in **Table 2.3-3**.

Based on GIS analysis, as of the end of 2003, the existing development-related disturbance to vegetation communities (less riparian and wetland vegetation) in the study area was 119,800 acres, of which 50,790 acres of disturbance was related to coal mining activity (see **Tables 2.3-2** and **2.3-3**, respectively). (See Section 2.3.3.2, Riparian and Wetland Vegetation, relative to riparian/wetland vegetation impacts.) The primary vegetation communities impacted as a result of coal mine development have included mixed-grass and short-grass prairie and sagebrush shrublands. Based on the Task 2 database, as of the end of 2003, approximately 136,284 acres of previously disturbed vegetation had been reclaimed, inclusive of approximately 21,238 acres of vegetation disturbance in previously mined areas (ENSR 2005a). It is assumed that the species composition on the reclaimed land is different than surrounding undisturbed lands, particularly in regard to the percent of woody shrub species during the early years following reclamation. Reclaimed mine land is defined by WDEQ as affected land that has been backfilled, graded, topsoil reapplied, and permanently seeded according to approved practices specified in the reclamation plan (Christensen 2002).

The figures showing vegetation (**Figure 2.3-1**) and land use (**Figure 2.7-2**) depict differing distribution of agricultural land within the PRB study area. The extent of agricultural land on these two figures varies because of the different sources used to derive the data. The figure for vegetation was derived from WGFD land cover and GAP data. BLM land use mapping data was the source for the figure for land use.

Other human disturbances to native vegetation typically are smaller in scale and are difficult to quantify in terms of affected acres. One such form of disturbance is damage to vegetation caused by fugitive dust that settles on plants primarily along the periphery of gravel roads. The source of fugitive dust is usually passing vehicles, but also may result from winds blowing across previously disturbed areas such as road corridors or over-grazed land. Fire suppression is another human-induced alteration of native vegetation. By suppressing wildland fires, humans have caused shifts in the vegetation types that are present in the PRB study area. Grazing presents another form of widespread disturbance within the PRB study area, although no solid quantification of impacts to native vegetation can be ascertained. Finally, quantification of the impacts of species such as grasshoppers, Mormon crickets, and prairie dogs presents similar difficulties. Disturbance to native vegetation that results from the above factors is not included in the analysis of the PRB study area vegetation types.

2.3.3.2 Riparian and Wetland Vegetation

Wetland and riparian areas are highly important water-related features in the arid landscape of northeastern Wyoming. Wetland and riparian areas occur throughout the PRB study area in all 18 subwatersheds and typically are restricted to the lands immediately surrounding major and minor rivers, streams, creeks, draws, topographical depressions, lakes, and ponds. Many plant and wildlife species are found in no other habitat types (e.g., certain plant and bird species, amphibians, and turtles), while other wildlife species such as shorebirds, waterfowl, and weasels frequent these habitat types. These small, but important, ecosystems represent a vegetation structure, soil, and hydrology that is unique relative to the vast expanses of sagebrush and prairie grass that dominate the landscape of the region.

Four riparian and wetland vegetation types have been identified in the PRB study area, including forested riparian, shrubby riparian, herbaceous riparian, and wet meadow. These riparian

vegetation types are described below. The acres of occurrence of pre-disturbance riparian and wetland vegetation types within the PRB study area are presented by subwatershed in **Table 2.3-1**.

Forested Riparian

The forested riparian vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the PRB study area. Areas covered by forested riparian vegetation are more common along some drainages today than in pre-settlement times due to the reduced frequency of tree-damaging floods as a result of reservoir construction and lateral drainage from irrigated uplands (Knight 1994). Forested riparian areas may be shrinking in other locations, particularly where cottonwoods are dominant, because of low cottonwood regeneration rates. This vegetation community is characterized by a variety of deciduous and coniferous tree species that occur along riparian areas, as defined by WGFD. Coniferous forested riparian areas are rare, occurring only in the foothills of the Big Horn Mountains along the western edge of the PRB study area. Deciduous forested riparian areas are much more common and occur throughout the PRB study area. Some common species include plains cottonwood (*Populus deltoides*), narrow-leaf cottonwood (*Populus angustifolia*), quaking aspen, boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), Russian olive (*Elaeagnus angustifolia*), and willow (*Salix* spp). This vegetation community occurs along the major drainages throughout the PRB study area.

Shrubby Riparian

The shrubby riparian vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community includes a variety of shrub and herbaceous plant species that exist adjacent to draws, gullies, and streams. Within the PRB study area, plant species in this vegetation type may include hawthorn (*Crataegus* spp.), chokecherry (*Prunus virginiana*), peachleaf willow (*Salix amygdaloides*), sandbar willow (*Salix exigua*), other willow species (*Salix* spp.), silver sagebrush, bluejoint reedgrass (*Calamagrostis canadensis*), and tufted hairgrass (*Deschampsia cespitosa*). This vegetation type occurs in small, scattered locations throughout the PRB study area.

Herbaceous Riparian

The herbaceous riparian vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community consists of a variety of riparian moist grasses, sedges, and rushes. Herbaceous riparian vegetation occurs near drainages including rivers, streams, and creeks. This vegetation community includes plant species common to the wet meadow vegetation type and may include woolly sedge (*Carex lanuginosa*), common spike-rush (*Eleocharis palustris*), foxtail barley (*Hordeum jubatum*), wild licorice (*Glycyrrhiza lepidota*), and Canada goldenrod (*Solidago canadensis*). Very similar to the wet meadow vegetation type, this vegetation cover type often occurs in similar environments. Herbaceous riparian communities occur throughout the PRB study area with most occurrences associated with streams, rivers, and other aquatic habitats.

Wet Meadow

The wet meadow vegetation community accounted for 2 percent of the pre-disturbance vegetation in the PRB study area. This vegetation community is a combination of green and very green

herbaceous rangeland types, as defined by WGFD. Wet meadow is a grassland vegetation community that typically occurs on fine-textured soils in valley bottoms where the water table is high enough to saturate the soil during a portion of the growing season. In addition, this vegetation community commonly occurs where springs emerge, along reservoirs, and in irrigated pastures (Knight 1994). Depending on salinity and water table, common species include Baltic rush (*Juncus balticus*), Nebraska sedge (*Carex nebrascensis*), prairie cordgrass (*Spartina pectinata*), and redtop bentgrass (*Agrostis stolonifera*). Species composition in the proximity of human activity, such as reservoirs and irrigated pasture, tends to exhibit dominance by introduced species such as Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), and smooth brome (*Bromus inermis*). Within the PRB study area, wet meadow habitats are widely distributed and often insular in their occurrence. Wet meadows are more common in the northern and western portions of the PRB study area than in the southern and eastern portions. Wet meadows tend to exist as island habitats surrounded by dominant plant communities such as grasslands or shrublands.

The extent and distribution of these four wetland/riparian vegetation types is shown in **Figure 2.3-1**. However, many of the riparian areas in the PRB study area are too small to be plotted on a map of this scale, including the riparian corridors of nearly all of the major rivers and streams. Approximately 3 percent of the PRB study area consists of riparian and wetland vegetation. Almost 47 percent (112,156 acres) of the approximately 242,000 acres of riparian areas and wetlands in the PRB study area is contained in the Upper Tongue River subwatershed. The dominant type of riparian area and wetland is the wet meadow that constitutes approximately 66 percent (approximately 160,000 acres) of all riparian areas and wetlands within the PRB study area. The subwatershed with the greatest proportion of riparian areas and wetlands, approximately 34 percent, is the Little Bighorn River. The Upper Tongue River subwatershed has the greatest extent (3,172 acres) of the forested riparian ecosystem; however, the North Fork Powder River subwatershed has the highest proportion, approximately 8 percent, of this type. The Upper Tongue River subwatershed has the greatest extent (32,931 acres) of the shrubby riparian ecosystem; however, the Little Bighorn River subwatershed has the highest proportion (approximately 21 percent) of this type. The Dry Fork Cheyenne River subwatershed has the greatest extent (5,198 acres) of the herbaceous riparian ecosystem and the highest proportion (almost 2 percent) of this type. The Upper Tongue River subwatershed has the greatest extent (75,985 acres) and second-highest proportion (approximately 10 percent) of the wet meadow wetland type, but the Little Bighorn River subwatershed has the highest proportion (almost 11 percent) of this type.

Riparian and Wetland Ecosystem Functions

Riparian and wetland ecosystems have various functions that occur at the landscape scale, including: 1) flood storage and flood-peak desynchronization; 2) recharge to the groundwater aquifer; 3) flood-flow attenuation; 4) purification of water via removal of nutrients and toxic compounds; and 5) recreation (Carter 1986; Zinn and Copeland 2001). These functions apply to all riparian zones of the subwatersheds within the PRB study area. Evaporation rates in much of Wyoming, including the PRB study area, greatly exceed precipitation rates, and the gentle slopes or relatively flat valleys of many of the 18 subwatersheds contribute to generally low-flow, highly sinuous rivers and streams spaced widely apart that have very narrow and limited riparian corridors.

The ecological community-scale functions of riparian ecosystems include: 1) the presence of surface water and abundant soil moisture that attracts or facilitates plant and animal occurrence; 2) high productivity within various food chains; 3) disproportionate species richness and abundance

relative to surrounding areas; 4) diversity and interspersion of habitat features that create more niches for plants and animals; and 5) corridors for animal dispersion and migration (Brinson et al. 1981). The functions of riparian and wetland ecosystems at the ecological community scale ultimately depend on the hydrology of the watershed. The rates of sedimentation and nutrient deposition, as well as the energy of water flow and local soil types, affect the vegetation community that establishes itself and thrives in the riparian zone. Other factors that influence the riparian vegetation include elevation and moisture gradients, floodplain width, and shallow groundwater depth. These components also influence the wildlife communities that are attracted to, and use, the riparian zone.

Hunters, anglers, bird watchers, and biologists have long recognized the value of riparian ecosystems to fish and wildlife. Riparian ecosystems are particularly valuable in a dry environment such as Wyoming. It has been estimated that, although only 1 percent or less of the region is classified as riparian land, approximately 80 percent of the native animals depend on riparian zones for food, water, shelter, and migration routes during some time of the year (Olson and Gerhart 1982). Riparian ecosystems are known for high animal species richness relative to other ecosystem types. Individual stands of riparian woodland average 20 to 34 species of breeding birds, and population densities of breeding birds in riparian areas average 1.5 to almost 6 pairs per acre. Riparian woodlands also may contain, on average, 5 to 30 species of mammals with a comparable species richness for amphibians and reptiles (Brinson et al. 1981). Based on the GAP model analysis, it is estimated that 201 to 319 species of terrestrial vertebrates inhabit the wetland and riparian areas in the PRB study area (University of Wyoming 2002).

Existing Wetland and Riparian Impacts

Alteration of hydrologic conditions can affect the physical and chemical properties in a wetland, such as pH, soil salinity, sediment properties, oxygen content, and nutrient availability. These wetland properties affect the biota in terms of establishment, recruitment, maintenance, and spatial arrangement. Small changes in the hydrologic conditions can result in massive responses by wetland biota in terms of species composition, species richness, and ecosystem productivity (Mitsch and Gosselink 1993). Peak flows, periodic flooding, and related stream channel processes, such as meandering, are closely related to the reproduction and growth of riparian plant species (Busch and Scott 1995). The maintenance of cottonwood and willow populations in riparian ecosystems depends on ground availability of water that, in turn, depends on instream flows (Busch et al. 1992). Changes to the interrelationships among surface water dynamics, groundwater level, and river channel processes can lead to changes in the establishment and maintenance of dependent riparian plant communities (Busch and Scott 1995).

The primary existing impacts to the riparian ecosystems of the PRB study area (e.g., livestock grazing and agricultural water withdrawals) are similar to riparian ecosystems throughout the West. Riparian vegetation and the availability of water in an otherwise dry landscape tend to attract livestock. Livestock spend more time grazing in riparian ecosystems than in adjacent uplands. Grazing along primarily low-order streams can cause increased erosion and sedimentation, decreased water quality via introduction of pathogens and excess nutrients, and channel downcutting (Brinson et al. 1981; Kauffman and Kreuger 1984). Grazing removes plants through consumption and trampling, particularly young plants, thereby affecting the age structure and reproduction of the plant population. Species composition of the riparian ecosystem also may be altered (Brinson et al. 1981). As a result of these impacts, the functions of the riparian and wetland

ecosystems may be diminished or disappear altogether. The potential indirect effects that would follow include increased flows, diminished flood storage capacity, increased frequency of flooding, increased upland erosion and sedimentation, decreased water quality, increased water temperature, and decreased aquatic biota species diversity. Details regarding the current condition of riparian ecosystems on specific rivers within the PRB study area are not available.

Agricultural uses have, in many cases, diminished the minimum instream flows necessary to sustain aquatic life and the riparian ecosystem for numerous streams and rivers in the arid Rocky Mountain states (Mitsch and Gosselink 1993). Water withdrawal reduces the availability of water for the maintenance of riparian ecosystems and, in extreme cases, can alter the composition of the plant community to include more upland species or eliminate the riparian or wetland ecosystem. Water diversions and withdrawals also can upset the salt balance by minimizing the flood frequency that usually leaches soil salts within the floodplain (Brinson et al. 1981). Additionally, return flows from irrigated fields in the arid West often contain high levels of inorganic salts, selenium, and other metals that may negatively affect water quality in the rivers or streams. Downstream uses (e.g., municipal and livestock water supply and aquatic habitat) may be adversely affected by excessive amounts of salts and metals that currently are being introduced by the return flows from irrigated fields. The existing water quality parameters (e.g., concentrations of metals such as selenium, sodium adsorption ratio, salinity, and total dissolved solids) are discussed in the Task 1B Report for the PRB Coal Review, Water Resources (ENSR 2005c). Ninety-eight percent of the surface water withdrawals from the rivers and streams in the PRB study area are for irrigation. Approximately one-third of the surface water withdrawals in the PRB study area occur in the Upper Tongue River subwatershed. The other major surface water withdrawals occur in the North Fork Powder River (17 percent) and Clear Creek (13 percent) subwatersheds. Recent data on surface water withdrawal for the Upper Tongue River subwatershed indicate that nearly twice the mean flow and approximately 50 percent of the maximum flow were withdrawn for irrigation. Consequently, little, if any, water flows under these conditions were reaching riparian areas and wetlands that historically had received normal water flows. As a result, many riparian ecosystems and wetlands in the Upper Tongue River subwatershed, and in other subwatersheds with major water withdrawals, may have been eliminated or substantially degraded in recent years.

Based on GIS analysis, as of the end of 2003, the existing development-related disturbance to wetland and riparian areas in the study area was 2,090 acres, of which 317 acres of disturbance was related to coal mining activity (see **Tables 2.3-2** and **2.3-3**, respectively). The primary communities impacted as a result of coal mine development have included shrubby riparian and wet meadows.

Water that is produced by the extraction of CBNG currently is being gathered from individual wells and discharged at the surface. In 2000, almost 4,000 permitted outfalls were discharging water at the surface within the PRB study area (WDEQ 2001). Nearly all (94 percent) of these discharges were related to CBNG wells. Approximately 50 percent of the permitted outfalls are within the Upper Belle Fourche River subwatershed, while 21 percent are in the Upper Powder River subwatershed, and 14 percent are in the Little Powder River subwatershed (BLM 2003a). It is not known how much of the produced water reaches the streams and wetlands of the subwatersheds of the PRB study area. Some stream segments, including ephemeral and often dry segments, received produced water continuously over the course of the year 2000. It can be assumed that existing riparian areas that received continuous input of produced water were affected through abnormal inundation, overly saturated soils, increased flow velocity and subsequent erosion, impediment of seedling

recruitment, and other factors. The water quality of the produced water from existing CBNG wells also is likely to cause adverse effects to riparian ecosystems and wetlands (BLM 2003a). Sodium absorption ratios of 13 or more can cause irreversible changes to soil structure that cause reduced percolation of rainfall and surface water flows, restrict root growth, limit permeability of gases and moisture, and cause difficult tillage (Seelig 2000; U.S. Salinity Laboratory Staff 1954). Such effects from the releases of produced water during recent years may have caused increased erosion of uplands leading to greater sedimentation in riparian areas and wetlands, as well as a reduction in plant seedling recruitment and vigor of established plant communities (BLM 2003a).

2.3.3.3 Invasive and Non-native Species

Once established, invasive and non-native plant species can outcompete and eventually replace native species, thereby reducing forage productivity and the overall vigor of existing native plant communities. The State of Wyoming has designated 25 plant species as noxious weeds. These species are listed in **Table 2.3-4**.

Table 2.3-4
State of Wyoming Designated Noxious Weeds

Common Name	Scientific Name
Russian knapweed	*Acroptilon repens*
Skeletonleaf bursage	*Ambrosia tomentosa*
Common burdock	*Arctium minus*
Hoary cress	*Cardaria draba*
Hairy whitetop	*Cardaria pubescens*
Plumeless thistle	*Carduus acanthoides*
Musk thistle	*Carduus nutans*
Diffuse knapweed	*Centaurea diffusa*
Spotted knapweed	*Centaurea biebersteinii*
Canada thistle	*Cirsium arvense*
Field bindweed	*Convolvulus arvensis*
Houndstongue	*Cynoglossum officinale*
Quackgrass	*Elymus repens*
Leafy spurge	*Euphorbia esula*
Common St. Johnswort	*Hypericum perforatum*
Dyer's woad	*Isatis tinctoria*
Perennial pepperweed	*Lepidium latifolium*
Ox-eye daisy	*Leucanthemum vulgare*
Dalmation toadflax	*Linaria dalmatica*
Yellow toadflax	*Linaria vulgaris*
Purple loosestrife	*Lythrum salicaria*
Scotch thistle	*Onopordum acanthium*
Perennial sowthistle	*Sonchus arvensis*
Saltcedar	*Tamarix chinensis*
Common tansy	*Tanacetum vulgare*

Wyoming is experiencing rapid introduction and spread of noxious weeds on all lands throughout the state, regardless of surface ownership. The potential for noxious weeds to continue spreading to new areas, particularly areas of disturbance, is high. As a collaborative effort, the BLM, South Goshen Cooperative Extension Conservation District, Wyoming Department of Agriculture, NRCS,

and 42 private surface owners joined WGFD and Weed and Pest District officials in efforts to control the spread of noxious weeds. This group agreed to a long-term integrated weed management plan, public awareness and prevention programs, and a common inventory, while monitoring and reporting on their progress.

Noxious weeds occur throughout the PRB study area. Their occurrence, distribution, and density are variable and are influenced by many factors, including disturbance type and frequency, climatic conditions, soil conditions, and local management efforts. Noxious weed lists are maintained by the Wyoming Department of Agriculture and by county weed and pest districts. Data relative to known occurrences of noxious weeds or species of concern are scarce. However, county-specific information obtained from the University of Wyoming Cooperative Agricultural Pest Survey (CAPS) detailing the estimated acres of infestation for four of the state-designated noxious weeds is listed in **Table 2.3-5**.

Table 2.3-5
Known Occurrences of Noxious and Invasive Species of Concern

Species	Campbell County	Converse County	Johnson County	Sheridan County
Broom snakeweed	Yes	Yes	Yes	Yes
Buffalobur	Yes	Yes	Yes	Yes
Bull thistle	No	Yes	Yes	Yes
Cheatgrass	Yes	Yes	Yes	Yes
Common cocklebur	Yes	Yes	Yes	Yes
Common lambsquarters	Yes	Yes	Yes	Yes
Common mullein	Yes	Yes	Yes	Yes
Common sunflower	Yes	Yes	Yes	Yes
Curlycup gumweed	Yes	Yes	Yes	Yes
Dyer's woad	No	No	No	No
Halogeton	Yes	Yes	Yes	No
Kochia	Yes	Yes	Yes	Yes
Milkweed	Yes	Yes	No	No
Ox-eye daisy	No	No	Yes	Yes
Perennial sowthistle	Yes	Yes	No	No
Pigweed	Yes	Yes	Yes	Yes
Plains larkspur	Yes	Yes	No	No
Platte thistle	No	Yes	Yes	No
Plumeless thistle	No	Yes	Yes	No
Pricklypear cactus	Yes	Yes	Yes	Yes
Puncturevine	No	Yes	No	No
Ragweed	Yes	Yes	Yes	Yes
Russian thistle	Yes	Yes	Yes	No
Sandbur	Yes	Yes	N/A	N/A
Sulfur cinquefoil	Yes	No	No	Yes
Sumpweed	N/A	Yes	Yes	Yes
Tarweed	N/A	Yes	N/A	N/A
Wild licorice	Yes	Yes	Yes	Yes
Wild oat	Yes	Yes	Yes	Yes
Yellow bedstraw	No	Yes	No	No

Sources: Dorn 1992; CAPS 1999; Gonzales 2005; Griswold 2002; Lewis 2002; and Litzel 2002.

N/A = Not available.

In addition to the state-designated list of noxious weeds, Campbell, Converse, Johnson, and Sheridan counties declared weeds of concern in the year 2000 under the authority of the Wyoming Weed and Pest Control Act. Noxious weeds tracked by individual counties include: common cocklebur (*Xanthium strumarium*) and wild licorice (*Glycyrrhiza lepidota*) in Campbell county; chicory (*Cichorium intybus*) and Dames rocket (*Hesperis matronalis*) in Converse County; and common mullein (*Verbascum thapsus*), common cocklebur, and wild licorice in Johnson County. No noxious weed species were identified for tracking in Sheridan County.

The distribution and spread of many plant species of concern currently are being monitored by CAPS in association with county weed and pest districts and the Wyoming Department of Agriculture. Some additional species being monitored that occur within the PRB study area include: broom snakeweed (*Gutierrezia sarothrae*), buffalobur (*Solanum rostratum*), bull thistle (*Cirsium vulgare*), cheatgrass (*Bromus tectorum*), common lambsquarters (*Chenopodium album*), common sunflower (*Helianthus annuus*), curlycup gumweed (*Grindelia squarrosa*), halogeton (*Halogeton glomeratus*), kochia (*Kochia scoparia*), milkweed (*Asclepias* spp.), pigweed (*Amaranthus* spp.), plains larkspur (*Delphinium geyeri*), platte thistle (*Cirsium canescens*), pricklypear cactus (*Opuntia polyacantha*), puncturevine (*Tribulus terrestris*), ragweed (*Ambrosia* spp.) Russian thistle (*Salsola australis*), sandbur (*Cenchrus longispinus*), sulfur cinquefoil (*Potentilla recta*), sumpweed (*Iva xanthifolia*), tarweed (*Madia glomerata*), wild oat (*Avena fatua*), and yellow bedstraw (*Galium verum*).

Table 2.3-6 lists the known presence or absence per county of the plant species of concern monitored by the CAPS program and individual weed and pest control districts. Included in **Table 2.3-6** are state-designated noxious weeds where no estimates of the acres of infestation were available.

Although data relative to known occurrences of noxious weeds in the PRB study area is scarce, the actual occurrence potential is assumed to be commensurate with the type and frequency of disturbance and the site-specific reclamation and weed control measures that currently are or would be implemented.

2.3.3.4 Special Status Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed and federally proposed species that are protected under the Endangered Species Act (ESA), or are considered candidates for such listing by the U.S. Fish and Wildlife Service (USFWS), as well as BLM, USFS, and WGFD sensitive species.

In accordance with the ESA, as amended, land management agencies in coordination with the USFWS must ensure that any action that they authorize, fund, or carry out would not adversely affect a federally listed threatened or endangered species. In addition, as stated in Special Status Species Management Policy 6840 (6840 Policy) (Rel. 6-151), it also is BLM policy “to conserve listed species and the ecosystems on which they depend, and to ensure that actions requiring authorization or approval by the BLM are consistent with the conservation needs of special status

species and do not contribute to the need to list any special status species, either under the provisions of the ESA or other provisions" identified in the 6840 Policy.

Table 2.3-6
Occurrence of Noxious Weeds and Invasive Species of Concern in Campbell, Converse, Johnson, and Sheridan Counties

Species	Areal Extent of Infestation[1] (acres)						
	<10	11 to 100	101 to 1,000	1,001 to 5,000	5,001 to 10,000	>10,000	Known to Occur
Black henbane	Co	Ca					
Canada thistle					S	Ca, Co, J	
Common burdock		Ca	Co	J, S			
Dalmation toadflax	J, S	Co	Ca				
Diffuse knapweed		Co	Ca, J				
Field bindweed			Co	Ca, J			S
Foxtail barley				C			Ca, J
Hoary cress			Ca, Co, S	J			
Houndstongue		Ca		S	Co, J		
Jointed goatgrass			Ca,				
Leafy spurge		Co		Ca		J, S	
Musk thistle		Ca, S		J		Co	
Perennial pepperweed	Ca	Co					
Purple loosestrife	S						
Quackgrass			Co, S				Ca, J
Rush skeletonweed	Ca			J			
Russian knapweed			S	Ca, J	Co		
Saltcedar	Co	Ca	s				J
Scotch thistle	S	Ca, Co			J		
Skeletonleaf bursage					Ca		Co, J
Spotted knapweed		Co	Ca, J, S				
Yellow toadflax	Co, J, S						

[1]Ca = Campbell County, Co = Converse County, J = Johnson County, S = Sheridan County.

Source: CAPS 1999; Gonzales 2005; Griswold 2002; Lewis 2002; and Litzel 2002.

A total of eight special status plant species were identified as potentially occurring within the PRB study area, including one federally threatened species, six BLM sensitive species, and one USFS sensitive species. No WGFD sensitive species were identified in the PRB study area. The identified species, their associated habitats, and their potential for occurrence within the PRB study area are summarized below. Occurrence potential was evaluated for each species based on their habitat requirements and/or known distribution.

Ute Ladies'-tresses Orchid. Ute ladies'-tresses orchid (*Spiranthes diluvialis*) is listed as federally threatened (USFWS 1992). This species currently is known from western Nebraska, southeastern

Wyoming, north-central Colorado, northeastern and southern Utah, east-central Idaho, southwestern Montana, and central Washington. In Wyoming, the Ute ladies'-tresses orchid is known from the western Great Plains in Converse, Goshen, Laramie, and Niobrara counties. Rangewide, the Ute ladies'-tresses orchid occurs primarily on moist, sub-irrigated or seasonally flooded soils in valley bottoms, gravel bars, old oxbows, or floodplains bordering springs, lakes, rivers, or perennial streams at elevations between 1,780 and 6,800 feet (Fertig 2000a). Suitable soils vary from sandy or coarse, cobbley alluvium to calcareous, histic, or fine-textured clays and loams. Populations have been documented from alkaline sedge meadows, riverine floodplains, flooded alkaline meadows adjacent to ponderosa pine, Douglas fir woodlands, sagebrush steppe, and streamside floodplains. Some occurrences also are found on agricultural lands managed for winter or early season grazing or hay production. Known sites often have low vegetative cover and may be subjected to periodic disturbances such as flooding or grazing. Populations are often dynamic and "move" within a watershed as disturbances create new habitat or succession eliminates old habitat (Fertig and Beauvais 1999).

In Wyoming, this species is known from four occurrences, all discovered between 1993 and 1997 (Fertig 2000b). As reported by Fertig (2000b), the only population known to occur within the PRB study area is located in Converse County, along a tributary of Antelope Creek. The BLM Casper Field Office administers the land at this location. This population is characterized as stable, with the number of observed individual plants varying between 11 and 35 during the period between 1990 and 1994. The three remaining Wyoming populations found outside of the PRB study area are located in Goshen, Niobrara, and Laramie counties on lands owned by the State of Wyoming and private parties. These populations are characterized as stable to increasing.

Laramie Columbine. The Laramie columbine (*Aquilegia laramiensis*) is a BLM sensitive species. This species is endemic to the Laramie Range of southeast Wyoming (Fertig 2000c) where it is known from eight extant populations in extreme southern Converse County and northern Albany County (Fertig and Beauvais 1999). The Laramie columbine is often found in shady crevices of north-facing granite boulders and cliffs with pockets of rich soil at elevations between 6,250 and 8,000 feet amsl (Fertig 2000c). Although no documented occurrences within the PRB study area have been identified, this species may occur in the area within suitable habitats.

Porter's Sagebrush. The Porter's sagebrush (*Artemisia porteri*) is a BLM sensitive species. The species is endemic to Wyoming and is restricted to the Wind River and Powder River basins in Fremont, Johnson, and Natrona counties. Suitable habitat includes sparsely vegetated badlands of ashy or tufaceous mudstones and clay slopes at elevations between 5,300 and 6,500 feet amsl. In the northern Wind River Basin, this species is found in semi-barren, low desert shrub communities dominated by Porter's sagebrush, birdfoot sagebrush, and longleaf wormwood on dry, whitish, ashy-clay hills, gravelly-clay flats, and shaley erosional gullies of the Wagon Bed Formation (Fertig 2000a). Porter's sagebrush is known from eight extant populations in Fremont, Johnson, and Natrona counties (Fertig 2000a). One of the documented populations in southwestern Johnson County is within the PRB study area. This species also may occur in other suitable habitats within the PRB study area.

Nelson's Milkvetch. The Nelson's milkvetch (*Astragalus nelsonianus*) is a BLM sensitive species. The species is regionally endemic to southwestern and central Wyoming, northeastern Utah, and northwestern Colorado. In Wyoming, it is known from the Wind River, Green River, Washakie, southern Powder River, and Great Divide basins; Owl Creek Mountains; and the Rock Springs

Uplift in Fremont, Natrona, and Sweetwater counties. Suitable habitat for this species includes alkaline, often seleniferous, clay flats, shale bluffs and gullies, pebbly slopes, and volcanic cinders. Known occurrences are found primarily in sparsely vegetated sagebrush, juniper, and cushion plant communities at elevations between 5,200 and 7,600 feet amsl (Fertig 2000e). This species is known from 24 extant populations, all located on private lands within central Wyoming (Fertig 2000e). Three populations are known from Johnson County, two of which are located in the eastern portion of the county and within the PRB study area. This species also may occur in other suitable habitats within the PRB study area.

Many-stemmed Spider-flower. The many-stemmed spider-flower (*Cleome multicaulis*) is a BLM sensitive species. Its global distribution includes central Mexico (near Mexico City) to southeastern Arizona, southwestern New Mexico, and southwestern Texas, with disjunct populations in south-central Colorado and central Wyoming. Wyoming populations are restricted to the Sweetwater River Valley in Natrona County. In Wyoming, the many-stemmed spider-flower primarily is found on whitish, alkali-rich, strongly hydrogen-sulfide scented soils that border shallow, spring-fed playa lakes or dried lakebeds. Populations are most abundant on damp, but not flooded, flats with approximately 90 percent cover of alkali-cordgrass, desert saltgrass, Baltic rush, Nuttall's alkali grass, Nevada bulrush, and sea arrowgrass bordering playa lakes. This species also may be present in lower numbers on clayey dunes surrounding alkaline lakes with less than 50 percent cover of cordgrass, arrowgrass, and alkali sacaton or on low hummocks of greasewood. Small patches also may occur in dry alkaline depressions with 20 percent cover of saltgrass, cordgrass, plains sea-blite, smooth hawk's beard, and goldenweed. All Wyoming colonies occur at an elevation of approximately 5,860 feet amsl (Fertig 2000f). This species is known from a single extant site in Natrona County (Fertig 2000f). Based on the species distribution, it is not expected to occur within the PRB study area.

Williams' Wafer-parsnip. The Williams' wafer-parsnip (*Cymopterus williamsii*) is a BLM sensitive species. This species is endemic to, and restricted to, the Big Horn Mountains of north-central Wyoming in Bighorn, Johnson, Natrona, and Washakie counties. Suitable habitat includes open, south, or east-facing ridge tops and upper slopes with exposed limestone outcrops or talus at elevations between 6,000 and 8,300 feet amsl. Suitable soils tend to be thin, sandy, and often restricted to small cracks or pockets in limestone bedrock. Barren rock can provide up to 50 percent of the total cover. This species usually is absent or very uncommon where grass cover is high or where western mountain mahogany and ponderosa pine are dominant. It also tends to be absent from lower slopes or valley bottoms with deeper or better-developed soils. Common associates include timber milkvetch, spatulate milkvetch, alpine bladderpod, whitlow-wort, and stemless hymenoxys (Fertig 2000g). This species is known from 23 extant populations found in the limestone or talus outcrops of the Big Horn Mountains (Fertig 2000g). It may occur in suitable habitats in Johnson County and other suitable habitats within the PRB study area.

Laramie False-sagebrush. The Laramie false-sagebrush (*Sphaeromeria simplex*) is a BLM sensitive species. This species is endemic to southeastern Wyoming in the western foothills of the Laramie Range, Shirley Basin, and Shirley Mountains. The species occupies gentle slopes or rims of dry, rocky limestone-sandstone "pebble plains" in wind-scoured openings. It occurs in cushion plant communities within more densely vegetated stands of juniper, limber pine, big sagebrush, or mountain mahogany at elevations of 7,200 to 8,760 feet amsl (CPC 2004). This species is known from 11 extant populations that occur in Albany, Carbon, Converse, and Natrona counties (Fertig 2000i). All of the known populations in Converse County occur in the southern portion of the county

and south of the southern extent of the PRB study area. Based on the species distribution, it is not expected to occur within the PRB study area.

Barr's Milkvetch. The Barrs' milkvetch (*Astragalus barrii*) is a USFS sensitive species. Its global distribution includes northeastern Wyoming and adjacent southeastern Montana, southwestern South Dakota, and northwestern Nebraska. In Wyoming, this species is known in Campbell, Johnson, Natron, Niobrara, Sheridan, and Weston counties. The Barr's milkvetch occurs primarily on buttes, hilltops, badlands, and gullied knolls and draws at elevations between 2,940 and 4,000 feet amsl. Suitable soil characteristics consist of shallow rocky soils derived from limestone, calcareous sandstone, shale, or siltstone. This species is indicative of a cushion plant community comprised of a more densely vegetated mixed grass prairie (CPC 2000). It is known from 27 extant populations throughout the PRB. Twelve of the populations are within the PRB study area including one in Sheridan County, seven in Johnson County, and four in Campbell County. Based on its distribution, the Barr's milkvetch may occur in suitable habitats within the PRB study area (University of Wyoming 1998).

2.3.4 Comparison to Previous Predictions

Vegetation within the study area has been disturbed by various development activities associated with coal mines, other mines, power plants, transmission lines, pipelines, reservoirs, coal technology plants, railroads, CBNG, and conventional oil and gas. Reclamation has been completed within some of these disturbance areas, thereby minimizing the overall acreage of remaining vegetation disturbance and the time for vegetation to reestablish.

Predictions made in earlier EISs (BLM 1979, 1981) for development-related disturbance and reclamation activities in the PRB were compared in the Coal Development Status Check (BLM 1996) to actual 1990 and 1994 disturbance and reclamation data. Based on the data in the 1996 document, actual disturbance and reclamation acreages affecting vegetation in 1994 were 73,321 and 21,964, respectively. In comparison, the existing disturbance acreage affecting vegetation at the end of 2003 (based on GIS analysis) was 121,890 (ENSR 2005b). Based on the Task 2 database, as of the end of 2003, a total of approximately 136,284 acres of previously disturbed vegetation had been reclaimed (ENSR 2005a).

The majority of the disturbance in the basin primarily has occurred in sagebrush-dominated vegetation types. Subsequent reclamation, where completed in these disturbance areas, likely has resulted in the reestablishment of immature sagebrush-dominated and grass- and forb-dominated communities.

2.4 Wildlife, Fisheries, and Related Habitat Values

2.4.1 Key Issues

The key issues for wildlife, fisheries, and related habitat values in the PRB study area as a result of mineral and industrial development can be classified as short-term and long-term. Potential short-term impacts arise from habitat removal and disturbance associated with a project's development and operation (e.g., coal mines, CBNG wells, etc.) and would cease upon project completion and successful reclamation in a given area. Long-term impacts consist of permanent changes to habitats and the wildlife populations that depend on those habitats, irrespective of reclamation success, and habitat disturbance related to longer term projects (e.g., power plant facilities, rail lines, etc.). Direct impacts to wildlife populations as a result of mineral and industrial development could include limited direct mortalities, habitat loss or alteration, habitat fragmentation, and animal displacement. Indirect impacts could include increased noise, additional human presence, and the potential for increased vehicle-related mortalities. The severity of both short- and long-term impacts would depend on factors such as the sensitivity of the species impacted, seasonal use patterns, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, and climate).

2.4.2 Study Area

The study area for wildlife, fisheries, and related habitat values includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (**Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**). Subwatersheds in the study area are shown in **Figure 1-4**.

2.4.3 Current Conditions

2.4.3.1 Wildlife Habitats

Common wildlife species that typically occur in short-grass and mixed-grass prairie habitats include prairie rattlesnake (*Crotalus viridis*), golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), sharp-tailed grouse (*Tympanchus phasianellus*), lark bunting (*Calamospiza melanocorys*), horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), lark sparrow (*Chondestes grammacus*), vesper sparrow (*Pooecetes gramineus*), chestnut collared longspur (*Calcarius ornatus*), McCown's longspur (*Calcarius mccownii*), badger (*Taxidea taxus*), coyote (*Canis latrans*), swift fox (*Vulpes velox*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), black-tailed jackrabbit (*Lepus californicus*), Ord's kangaroo rat (*Dipodomys ordii*), deer mouse (*Peromyscus maniculatus*), western harvest mouse (*Reithrodontomys megalotis*), plains pocket gopher (*Geomys bursarius*), black-tailed prairie dog (*Cynomys ludovicianus*), and pronghorn *(Antilocapra americana*).

Common wildlife species that typically occur in sagebrush shrublands include: eastern short-horned lizard *(Phrynosoma douglasii brevirostre*), prairie rattlesnake, northern harrier (*Circus cyaneus*),

Swainson's hawk, greater sage-grouse (*Centrocercus urophasianus*), Say's phoebe (*Sayornis saya*), western kingbird (*Tyrannus verticalis*), horned lark, sage thrasher (*Oreoscoptes montanus*), Brewer's sparrow (*Spizella breweri*), vesper sparrow, sage sparrow *(Amphispiza belli*), western meadowlark, desert cottontail (*Sylvilagus audubonii*), black-tailed jackrabbit, thirteen-lined ground squirrel, northern pocket gopher (*Thomomys talpoides*), Ord's kangaroo rat, deer mouse, prairie vole (*Microtus ochrogaster*), pronghorn, and mule deer (*Odocoileus hemionus*).

Common wildlife species that typically occur in other shrublands are similar to those that inhabit sagebrush shrublands, and include: garter snake (*Thamnophis elegans*), chukar (*Alectoris chukar*), sharp-tailed grouse (*Tympanuchus phasianellus*), western kingbird, horned lark, black-billed magpie (*Pica pica*), rock wren (*Salpinctes obsoletus*), sage thrasher, lazuli bunting (*Passerina amoena*), spotted towhee (*Pipilo maculates*), Brewer's sparrow, lark sparrow, lark bunting, bobolink (*Dolichonyx oryzivorus*), masked shrew (*Sorex cinereus*), desert cottontail, least chipmunk (*Tamias minimus*), Wyoming ground squirrel (*Spermophilus elegans*), thirteen-lined ground squirrel, deer mouse, northern grasshopper mouse (*Onychomys leucogaster*), coyote, western spotted skunk (*Spilogale gracilis*), pronghorn, and mule deer.

Wildlife species that may occur in riparian areas (including herbaceous, shrubby, and forested riparian areas) include: bull snake (*Pituophis catenifer*), tiger salamander (*Ambystoma tigrinum*), northern leopard frog (*Rana pipiens*), northern harrier, Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), common snipe (*Gallinago gallinago*), short-eared owl (*Asio flammeus*), marsh wren (*Cistothorus palustris*), common yellowthroat (*Geothlypis trichas*), savannah sparrow (*Passerculus sandwichensis*), song sparrow (*Melospiza melodia*), red-winged blackbird (*Agelaius phoeniceus*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), deer mouse, meadow vole (*Microtus pennsylvanicus*), red fox (*Vulpes vulpes*), pronghorn, mule deer, and white-tailed deer (*Odocoileus virginianus*). Wet meadows tend to provide habitats for wildlife species associated with nearby dominant vegetation cover types (such as prairie or sagebrush shrublands), although in areas of large wet meadow complexes species common to riparian habitats also may occur.

Common wildlife species in coniferous forest include: mountain chickadee (*Poecile gambeli*), mourning dove (*Zenaida macroura*), golden eagle, mountain bluebird (*Sialia currucoides*), northern flicker (*Colaptes auratus*), western tanager (*Piranga ludoviciana*), pinyon jay (*Gymnorhinus cyanocephalus*), chipping sparrow (*Spizella passerina*), lark sparrow, Nuttall's cottontail (*Sylvilagus nuttallii*), mule deer, gray fox (*Urocyon cinereoargenteus*), black-tailed jackrabbit, porcupine (*Erethizon dorsatum*), bushy-tailed woodrat (*Neotoma cinerea*), and mountain lion (*Felis concolor*).

A substantial amount of wildlife habitat has been impacted by past and present activities in the PRB study area. These disturbances include, but are not limited to, agriculture, mining, roads, urban areas, oil and gas well pads, compressor sites, and other ancillary facilities. Where data were available, the amount of this existing direct disturbance has been estimated and is included in the discussions for individual species below. A portion of the disturbed land on permitted coal mines has been reclaimed.

Coal mining, oil and gas development, and other industrial projects within the study area have resulted in both short- and long-term impacts, as well as direct and indirect impacts to wildlife species, as discussed in Section 2.4.1, Key Issues.

Tables 2.3-2 and **2.3-3** summarize the existing development-related disturbance (total and coal mine-related, respectively) to vegetation communities as of end of year 2003. Based on this GIS analysis, the existing development-related disturbance to associated wildlife habitats in the PRB study area totaled 121,890 acres, of which 51,107 acres of disturbance was related to coal mining activities (ENSR 2005b). The primary habitats impacted as a result of coal mine development have included mixed-grass and short-grass prairies and sagebrush shrublands. Lesser amounts of coniferous forest, riparian/wetland, and aquatic habitats also have been disturbed. Based on the Task 2 database, approximately 136,284 acres of previously disturbed wildlife habitat had been reclaimed, inclusive of approximately 21,238 acres of habitat in previously mined areas (ENSR 2005a)

2.4.3.2 Habitat Fragmentation

Considerable research has been conducted on the effects of habitat fragmentation on wildlife populations caused by a variety of human activities, including energy development. Habitat fragmentation from activities such as roads, well pads, mines, pipelines, and electrical power lines can result in the direct loss of potential wildlife habitat. Other effects from habitat fragmentation such as increased noise, elevated human presence, dispersal of noxious and invasive weed species, and dust deposition from unpaved road traffic can extend well beyond the surface disturbance boundary. These effects result in overall changes in habitat quality, habitat loss, increased animal displacement, reductions in local wildlife populations, and changes in species composition. However, the severity of these effects on terrestrial wildlife depend on factors such as sensitivity of the species, seasonal use, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, and climate). The following section examines the effects to various groups of species relative to available literature.

Habitat

Roads alter the temperature, humidity, sunlight intensity, moisture content of surrounding soils, and vegetation composition (Vaillancourt 1995). As a result, vegetation adjacent to the roads is dissimilar to surrounding vegetation, as measured by species composition, abundance, dust, and amount of bare soil and litter. Baker and Dillon (2000) summarized the effects on vegetation at a variety of sites and concluded the average depth-of-edge for vegetation effects was 200 feet (60 meters). Gelhard and Belnap (2003) showed that desert shrub communities located near maintained gravel and paved roads contained a large amount of exotic species, while plant communities near primitive, two-track roads were less disrupted compared to surrounding native vegetation. As a result, it is assumed that vegetation community composition would be altered for approximately 165 to 200 feet (50 to 60 meters) away from the roadsides, despite reclamation with native seed mixtures.

Big Game

Displacement of big game, as a result of direct habitat loss and indirect reduction in habitat quality, has been widely documented (Irwin and Peek 1983; Lyon 1983; Rost and Bailey 1979; Ward 1976). Big game species tend to move away from areas of human activity and roads, reducing habitat utilization near the disturbance areas. The distance big game are displaced is strongly influenced by the level and timing of the human activity, topography, and the presence of vegetation (Lyon 1979),

presumably due to noise attenuation and visual cover. Displacement of big game is greatest for heavily traveled secondary and dirt roads.

Most research has focused on displacement distances for elk and deer. Displacement distances indicate the distance from the road's centerline where animal densities are less than in surrounding areas (i.e., under-utilized habitat). In most circumstances, elk were not observed to habituate to human activities. Deer and pronghorn can be more tolerant of human activities than elk. For deer, displacement distances ranged from 330 feet to 0.6 mile (100 to 1,000 meters), depending on the presence of vegetative cover (Ward 1976). For evaluation purposes, 660 feet (200 meters) was the most common displacement distance used for deer, especially in areas with minimal vegetative cover. Deer and pronghorn have been observed to habituate to vehicles and displacement distances decreased when traffic was predictable, moving at constant speeds, and was not associated with out-of-vehicle activities (Ward et al. 1980; Ward 1976). However, in most cases, traffic within areas that experience energy development activities are characterized by slow moving traffic, vehicles that stop, and out of vehicle activity, thus, acclimation by big game would not be not anticipated.

A long-term monitoring plan currently is being conducted by Western EcoSystems Technology, Inc. to assess potential impacts of natural gas development on mule deer in the Pinedale Anticline Project Area in Sublette County, Wyoming. The initial results of this study, which is projected to culminate in 2007, suggest that winter mule deer habitat selection and distribution patterns have been affected by natural gas development, specifically as a result of construction of road networks and well pads. Assuming selected habitats prior to natural gas development were preferred over other habitats, these preliminary results suggest that natural gas development may displace mule deer to less preferred habitats. However, it is not known at this time whether these trends in habitat selection are temporary (i.e., deer become acclimated) or long-term (Western EcoSystems Technology, Inc. 2004).

Upland Game Birds

Oil and gas development has been shown to negatively impact greater sage-grouse populations as a result of pump noise and increased human disturbance. Greater sage-grouse have been observed to abandon lek sites in areas with increased road development (Braun 1986). Compared to hens in undisturbed leks, sage grouse hens that used breeding leks within approximately 2 miles (3.2 kilometers [km]) from oil and gas development moved farther away from breeding leks to nesting areas and had lower nest initiation rates (Lyon 2000). Furthermore, sage grouse hens that utilized habitats farthest from roads had greater brood survivorship than those hens utilizing habitat near roads (Lyon 2000). Pump noise from oil and gas development also appears to reduce the effectiveness of male grouse vocalizations on lek sites (Klott 1987). Connelly et al. (2000) recommends that energy-related facilities be located more than 2 miles (3.2 km) from active lek sites under ideal habitat conditions, 3 miles (5 km) when habitat conditions are not ideal, and 11 miles (18 km) when greater sage-grouse populations are migratory.

Chukar and ring-necked pheasant may experience increased mortality rates due to increased public access. Vehicular traffic may injure or kill individuals, and local populations may experience higher levels of hunting and poaching pressure due to improved public access. These species are relatively tolerant of human activity and are likely to occupy suitable habitat in reasonably close proximity to roads and well pads.

Raptors

For raptor species, habitat fragmentation can result in the loss or alteration in habitat, reduction in prey base, and increased human disturbance. The loss of native habitat to human development has resulted in declines of hawks and eagles throughout the West (Schmutz 1984; Boeker 1974). In some cases, habitat changes have not reduced numbers of raptors but have resulted in shifts in species composition (Harlow and Bloom 1987). Impacts to small mammal populations due to habitat loss and fragmentation can result in a reduced prey base for raptors, resulting in lower raptor densities. Thompson et al. (1982) found that golden eagles had lowered nesting success where native vegetation had been lost and was unable to support jackrabbit (prey) populations. Furthermore, the increased road network within the study area would lead to greater public access. As a result, raptors may be disturbed from nests and roosts causing displacement and reduced nesting success (Anderson and Squires 1997; Brown and Stevens 1997; Postovit and Postovit 1987; Stalmaster and Newman 1978). Noise levels and human activity also can preclude otherwise acceptable raptor habitat (USFWS 2002b). As with big game, vehicles that stop cause greater levels of disturbance than continuously moving vehicles (White and Thurow 1985).

Other Non-game Birds

Effects of high levels of daily traffic (less than 10,000 vehicles per day) on bird densities located near paved roads is well documented (Reijnen et al. 1995, 1996, 1997; Reijnen and Foppen 1995). These studies showed a reduction in bird densities from approximately 130 to 9,200 feet (40 to 2,800 meters) in forested habitats and approximately 70 to 11,600 feet (20 to 3,500 meters) in grassland habitats, depending on species and traffic volume (LaGory et al. 2001; Reijnen et al. 1997). In grassland habitats, Reijnen et al. (1996) determined that densities were reduced at distances ranging from approximately 70 to 5,600 feet (20 to 1,700 meters) along paved roads that received 5,000 vehicles per day on average. Seven of 12 species in this study showed a substantial negative relationship in population density of more than 10 percent reduction in bird density within 330 feet (100 meters) of the road (density reduction within 330 feet ranged from 12 to 56 percent). Only 2 of the 12 species showed any further reduction in density greater than 330 feet (100 meters) from a road (Reijnen et al. 1996). A study in west-central Wyoming on the effects of natural gas development on passerine birds within sagebrush-steppe habitat showed a 60 percent reduction in densities of sagebrush obligate species (Brewer's sparrow, sage sparrow, sage thrasher) that occur within 330 feet (100 meters) of both paved and unpaved roads, while horned lark population densities increased slightly within the 330-foot area. Horned larks are grassland species that commonly are observed foraging for windblown seed along dirt roadways and other disturbance areas. The average daily traffic volume within the study area ranged from 11 and 444 vehicles per day (Ingelfinger 2001).

Overall, reductions in bird population densities from roads in both open grasslands and woodlands are attributed to a reduction in habitat quality produced by elevated noise levels (Reijnen et al. 1995, 1997). Although visual stimuli in open landscapes may add to density effects at relatively short distances, the effects of noise appear to be the most critical factor since breeding birds of open grasslands (threshold noise range of 43 to 60 decibels on the A-weighted scale [dBA]) and woodlands (threshold noise range of 36 to 58 dBA) respond very similarly to disturbance by traffic volume (Reijnen et al. 1997). Reijnen et al. (1996) determined a threshold effect for bird species to be 47 dBA, while a New Mexico study in a piñon-juniper community found that effects of gas well

compressor noise on bird populations were strongest in areas where noise levels were greater than 50 dBA. However, moderate noise levels (40 to 50 dBA) also showed some effect on bird densities in this study (LaGory et al. 2001).

As a result, habitat fragmentation effects have resulted from long-term surface disturbance activities in the study area. Indirect effects from human presence, dispersal of noxious and invasive weeds, and dust effects from unpaved road traffic potentially have further reduced habitat quality and wildlife utilization in the study area. Collectively, it is conceivable that these effects have resulted in overall changes in habitat quality, habitat loss, increased animal displacement, reductions in local wildlife populations, and changes in species composition to some degree. However, the severity of these effects on terrestrial wildlife depend on factors such as sensitivity of the species, seasonal use, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, and climate).

2.4.3.3 Terrestrial Wildlife

Big Game Species

Big game species that are expected to occur in suitable habitats throughout the PRB study area include pronghorn, white-tailed deer, mule deer, elk (*Cervus elaphus*), and moose (*Alces alces*). The PRB study area includes crucial winter yearlong and severe winter range for pronghorn; crucial winter range, crucial winter yearlong range, and parturition areas for elk; and crucial winter yearlong and crucial yearlong areas for moose. No crucial or severe winter ranges have been identified within the PRB study area for white-tailed deer or mule deer. No big game migration corridors are recognized by the WGFD in this area.

Pronghorn. Pronghorn are the most common big game species in the study area. They are present in the majority of the study area, except in the foothills in the western margin of the central portion of the area (**Figure 2.4-1**).

Typical suitable habitat for pronghorn includes grasslands and semi-desert shrublands located in the western and southwestern U.S. This species commonly inhabits short- and mixed-grass prairies and tends to avoid more xeric landscapes. Home ranges can vary considerably in size, spanning from 400 acres to 5,600 acres. Home range size is influenced by several factors including season, habitat quality, population characteristics, and local livestock occurrence. Daily movement usually does not exceed 6 miles. Some pronghorn make seasonal migrations between summer and winter habitats, but these migrations often are triggered by availability of succulent plants and not local weather conditions (Fitzgerald et al. 1994). Range data were extracted from the Final EIS for the PRB Oil and Gas Project (BLM 2003a). The type and distribution of pronghorn ranges by subwatershed are presented in **Table 2.4-1**.

WGFD divided pronghorn into herd units to estimate population sizes. The following herd units reside entirely or partially within the PRB study area: 308, 309, 310, 316, 318, 339, 351, 352, 353, 354, 740, 742, and 748. WGFD estimated the population size of all herd units within the study area to be 152,746 animals in 2003 (WGFD 2002b,c). This number excludes data from herd unit 742, which were unavailable. This group of herd units has an overall population goal of 138,600 animals. Therefore, population levels in 2003 were approximately 110 percent of the goal. Among individual herd units, population levels in 2003 ranged from 83 to 345 percent of population goals. Poor winter

SHERIDAN COUNTY
JOHNSON COUNTY
CAMPBELL COUNTY
CONVERSE COUNTY
DAYTON
SHERIDAN
BUFFALO
GILLETTE
WRIGHT
KAYCEE
Burlington Northern RR
Union Pacific RR
PP&L RR
I-90
I-25
14
14/16
16
59
387
Powder River
Clear Cr.
Crazy Woman Cr.
Fourmile Cr.
Pumpkin Cr.
Dry Fork Powder River
Dry Fork Cheyenne River
Antelope Cr.
Dry Cr.
Salt Cr.
Sage Cr.
Beaver Creek
Black Thunder Cr.
Little Thunder Cr.
Four Horse Cr.
Cottonwood Cr.
Little Powder River
Spotted Horse Cr.
Wild Cat Cr.
Middle Prong Wild Horse Cr.
West Horse Cr.
Rock Cr.
Prairie Dog Cr.
Tongue R.
Big Goose Cr.
Little Goose Cr.
Piney Cr.
Butler Cr.
North Fork Crazy Woman Cr.
South Fork Crazy Woman Cr.
Trabing Dry Cr.
Beds Fourche River
North Fork Powder River
Red Fork Powder River
Bear Trap Cr.
Middle Fork Powder River
Buffalo Cr.
South Fork Powder River

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

Pronghorn Ranges

- Crucial Winter Yearlong
- Spring, Summer, Fall
- Severe Winter Range
- Winter
- Winter Yearlong
- Yearlong

WYOMING

N
W
E
S

0 5 10 15 Miles

0 5 10 15 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003.

Powder River Basin Coal Review

Figure 2.4-1

Pronghorn Ranges

6/20/05

Table 2.4-1
Distribution of Pronghorn Ranges by Subwatershed
(acres)

Subwatershed	Crucial Winter Yearlong	Severe Winter	Spring, Summer, Fall	Winter	Winter Yearlong	Yearlong	Total
Little Bighorn River	0	0	0	0	0	1,010	1,010
Upper Tongue River	0	0	0	0	13,095	527,235	540,330
Middle Fork Powder River	0	0	59,887	0	118,112	42,363	220,362
North Fork Powder River	0	0	801	0	0	18,286	19,086
Upper Powder River	0	0	132	67,047	470,778	854,516	1,392,472
South Fork Powder River	0	0	0	0	57	114,151	114,208
Salt Creek	0	0	17,817	0	17,866	104,143	139,825
Crazy Woman Creek	0	0	18,580	0	36,565	446,033	501,178
Clear Creek	0	0	1,196	0	37,930	442,745	481,872
Middle Powder River	0	0	24,841	23,727	0	124,443	173,011
Little Powder River	0	0	0	66,185	218,718	446,048	730,951
Little Missouri River	0	0	0	0	6,406	27,558	33,964
Antelope Creek	0	31,773	221	0	57,524	570,716	660,234
Dry Fork Cheyenne River	0	19,195	0	0	83,172	206,949	309,316
Upper Cheyenne River	0	0	0	0	62,975	115,763	178,738
Lightning Creek	0	0	0	0	58,830	249,491	308,321
Upper Belle Fourche River	0	0	0	0	491,023	292,784	783,806
Middle North Platte River	145	0	0	0	120,466	91,963	212,574
Total	**145**	**50,968**	**123,476**	**156,959**	**1,793,516**	**4,676,195**	**6,801,259**

Source: BLM 2003a.

weather conditions, high fawn mortality, and limited forage availability accounted for the individual units that failed to reach goals. In several herd units, lack of public access for hunting has resulted in herd numbers that greatly exceed population goals (WGFD 2002a,c).

For pronghorn antelope in the study area, the overall population trend has been stable to increasing herd numbers. Herd unit 748 was the sole unit to exhibit a decreasing trend. This most likely is a result of bad winter weather causing high fawn mortality (WGFD 2002b,c). Extensive on-going and planned future energy development were considered potential management concerns for some herd units. For example, increased road density, produced water discharge, loss of vegetation, and increased human presence have had the potential to adversely affect herd units subject to CBNG development (WGFD 2002b,c).

Table 2.4-2 presents existing disturbance to pronghorn ranges by subwatershed.

Table 2.4-2
Existing Disturbance to Pronghorn Ranges by Subwatershed
(acres)

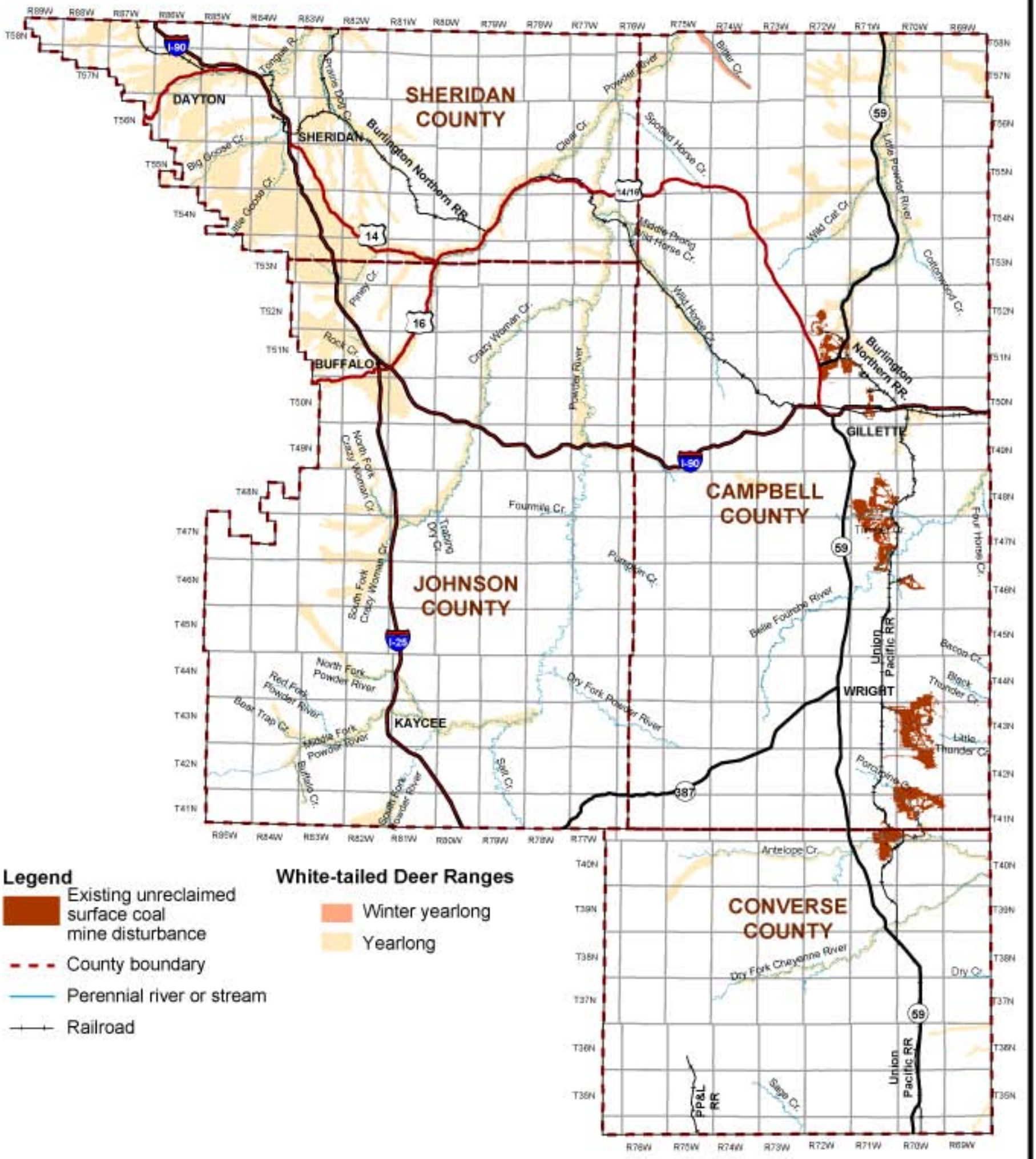
Subwatershed	Crucial Winter Yearlong	Severe Winter	Spring, Summer, Fall	Winter	Winter Yearlong	Yearlong	Total
Little Bighorn River	0	0	0	0	0	0	0
Upper Tongue River	0	0	0	0	435	2,297	2,732
Middle Fork Powder River	0	0	0	0	154	105	259
North Fork Powder River	0	0	0	0	0	0	0
Upper Powder River	0	0	0	1,019	4,204	6,480	11,703
South Fork Powder River	0	0	0	0	0	312	312
Salt Creek	0	0	18	0	18	657	693
Crazy Woman Creek	0	0	0	0	22	473	495
Clear Creek	0	0	0	0	255	2,524	2,779
Middle Powder River	0	0	387	302	0	1,472	2,161
Little Powder River	0	0	0	474	7,670	9,228	17,372
Little Missouri River	0	0	0	0	56	85	141
Antelope Creek	0	1,655	1	0	459	17,693	19,808
Dry Fork Cheyenne River	0	66	0	0	531	1,087	1,684
Upper Cheyenne River	0	0	0	0	13,862	2,681	16,543
Lightning Creek	0	0	0	0	693	2,206	2,899
Upper Belle Fourche River	0	0	0	0	22,323	14,488	36,811
Middle North Platte River	0	0	0	0	205	356	561
Total	**0**	**1,721**	**406**	**1,795**	**50,887**	**62,144**	**116,953**

Source: ENSR 2005b.

White-tailed Deer. Typically, white-tailed deer inhabit forests, swamps, brushy areas, and neighboring open fields. In Wyoming, white-tailed deer frequent riparian woodlands, shrubby riparian areas, and associated irrigated agricultural lands. Due to their dependence on moist habitats, white-tailed deer are restricted to river and stream drainages throughout the PRB and the riparian areas in the northern foothills of the Big Horn Mountains (**Figure 2.4-2**). White-tailed deer mortality usually is related to hunting, winter starvation, collision with vehicles, and predation. The type and distribution of white-tailed deer ranges by subwatershed are presented in **Table 2.4-3**.

The following herd units reside entirely or partially within the PRB study area: 303, 702, 707. Due to inadequate survey data, the WGFD only was able to estimate the size of herd unit 303. The 2003 estimate for this herd unit was 13,970, with a goal of 8,000 (WGFD 2002b). This species has a stable or increasing trend since populations are suspected to be considerably higher than the goals for each herd unit. Burgeoning population levels can be accredited to the inaccessibility of habitat in the northwestern part of the PRB study area, thus impeding hunting and urbanization.

Table 2.4-4 presents existing disturbance to white-tailed deer ranges by subwatershed.



Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

White-tailed Deer Ranges

- Winter yearlong
- Yearlong

N W E S

0 5 10 15 Miles

0 5 10 15 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003

Powder River Basin Coal Review

Figure 2.4-2

White-tailed Deer Ranges

6/20/05

Table 2.4-3
Distribution of White-tailed Deer Ranges by Subwatershed
(acres)

Subwatershed	Winter Yearlong	Yearlong	Total
Little Bighorn River	0	16,475	16,475
Upper Tongue River	0	265,926	265,926
Middle Fork Powder River	0	31,635	31,635
North Fork Powder River	0	0	0
Upper Powder River	0	71,095	71,095
South Fork Powder River	0	9,383	9,383
Salt Creek	0	321	321
Crazy Woman Creek	0	67,472	67,472
Clear Creek	0	130,988	130,988
Middle Powder River	4,671	12,554	17,225
Little Powder River	0	102,406	102,406
Little Missouri River	0	4,681	4,681
Antelope Creek	0	17,986	17,986
Dry Fork Cheyenne River	0	11,681	11,681
Upper Cheyenne River	0	0	0
Lightning Creek	0	4,731	4,731
Upper Belle Fourche River	0	13,633	13,633
Middle North Platte River	0	0	0
Total	**4,671**	**760,967**	**765,638**

Source: BLM 2003a.

Table 2.4-4
Existing Disturbance to White-tailed Deer Ranges by Subwatershed
(acres)

Subwatershed	Winter Yearlong	Yearlong	Total
Little Bighorn River	0	56	56
Upper Tongue River	0	2,116	2,116
Middle Fork Powder River	0	21	21
North Fork Powder River	0	0	0
Upper Powder River	0	1,087	1,087
South Fork Powder River	0	0	0
Salt Creek	0	2	2
Crazy Woman Creek	0	99	99
Clear Creek	0	1,561	1,561
Middle Powder River	26	23	49
Little Powder River	0	1,166	1,166
Little Missouri River	0	11	11
Antelope Creek	0	886	886
Dry Fork Cheyenne River	0	40	40
Upper Cheyenne River	0	0	0
Lightning Creek	0	48	48
Upper Belle Fourche River	0	321	321
Middle North Platte River	0	0	0
Total	**26**	**7,437**	**7,463**

Source: ENSR 2005b.

Mule Deer. Mule deer occur throughout western North America from central Mexico to northern Canada. In contrast to the white-tailed deer, mule deer inhabit a wide variety of habitats. Typical habitats include short grass and mixed-grass prairies, sagebrush and other shrublands, coniferous forests, and forested and shrubby riparian areas. In the PRB study area, mule deer ranges occur in all areas with the exception of a few areas located between Wright and Gillette (**Figure 2.4-3**). By nature, mule deer are more migratory than white-tailed deer. They migrate seasonally between high elevations in the summer to lower elevations in the winter. Mortality in adult mule deer typically involve hunting, winter starvation, and automobile collisions. Range data are based on seasonal range maps available from the WGFD. The type and distribution of mule deer ranges by subwatershed are presented in **Table 2.4-5**.

WGFD has divided mule deer into herd units to estimate populations. The following herd units reside entirely or partially within the PRB study area: 319, 320, 321, 322, 752, 753, and 755. WGFD estimated the population of all herd units within the study area to be 147,106 animals in 2003 (WGFD 2002b,c). This corresponds to a population goal of 153,100 animals; therefore, population levels were at 96 percent of the goal in 2003. Some herd units exceeded their goal, while others were below their goal. Among those units that were below their goal, poor weather conditions, high fawn mortality, and lack of reliable population estimates are most likely responsible. Overall, the mule deer population trend is relatively stable to decreasing; only two herd units have demonstrated increasing population trends. Specific impacts on mule deer populations are unknown; however, it is suspected that increased road density, produced water discharge, loss of vegetation, and heightened human presence may cause stress to the herd units in areas that are subject to considerable development.

Tables 2.4-6 presents existing disturbance to mule deer ranges by subwatershed.

Elk. In Wyoming, elk occupy a wide variety of habitats, including coniferous forests, mountain meadows, short- and mixed-grass prairies, and sagebrush shrublands. Elk are seasonal migrants, moving between summer and winter ranges. Mortality generally can be attributed to predation on calves, hunting, and winter starvation. In the PRB study area, elk are present in the Big Horn Mountains and nearby foothills, the Fortification Creek Area west of Gillette, the Pine Ridge area in the south, and the Rochelle Hills in the southeast (BLM 2003a) (see **Figure 2.4-4**). The type and distribution of elk ranges by subwatershed are presented in **Table 2.4-7**.

WGFD has divided elk into herd units to estimate population sizes. The following herd units reside entirely or partially within the PRB study area: 320, 321, 322, 344, and 743. WGFD has estimated the total population size of four of these herd units at 11,080 in 2003; however, survey data were not adequate to allow a population estimate of the size of herd unit 743. This herd unit is suspected of greatly exceeding the goal of 125 animals (WGFD 2002b,c). For the other four herd units, population levels are at 147 percent of the 7,550 goal. Each herd unit has met their targeted population level, with some even greatly exceeding it. Population levels range from 115 to 192 percent of the unit goals. Herd units that have experienced drastic growth have done so as a result of a lack of roads to access hunting and reluctance of private landowners to allow access on their lands for hunting. Elk in the PRB study area are exhibiting a stable to increasing population trend. However, some herd units have declined in response to management actions taken to decrease populations (WGFD 2002b,c). Similar to mule deer, increased road density, produced water discharge, loss of vegetation, and increased human presence have the potential to negatively affect elk herd. **Table 2.4-8** presents existing disturbance to elk ranges by subwatershed.

SHERIDAN COUNTY
CAMPBELL COUNTY
JOHNSON COUNTY
CONVERSE COUNTY
DAYTON
SHERIDAN
BUFFALO
GILLETTE
WRIGHT
KAYCEE
Burlington Northern RR
Union Pacific RR
PP&L RR
I-90
I-25
14
16
14/16
59
387

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

Mule Deer Ranges

- Spring, Summer, Fall
- Winter Yearlong
- Yearlong

WYOMING

N
W
E
S

0 5 10 15 Miles

0 4 8 12 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003

Powder River Basin Coal Review

Figure 2.4-3

Mule Deer Ranges

6/20/05

Table 2.4-5
Distribution of Mule Deer Ranges by Subwatershed
(acres)

Subwatershed	Spring, Summer, Fall	Winter Yearlong	Yearlong	Total
Little Bighorn River	1,427	44,368	3,790	49,584
Upper Tongue River	8,091	589,641	135,812	733,543
Middle Fork Powder River	101,251	341,119	22,080	464,450
North Fork Powder River	1,824	0	18,850	20,674
Upper Powder River	0	950,798	611,226	1,562,024
South Fork Powder River	0	75,343	39,012	114,355
Salt Creek	0	71,511	73,308	144,819
Crazy Woman Creek	13,373	368,629	166,281	548,283
Clear Creek	1,852	466,854	78,158	546,865
Middle Powder River	0	158,914	65,316	224,230
Little Powder River	0	468,752	291,837	760,589
Little Missouri River	0	37,105	1,422	38,528
Antelope Creek	0	68,433	517,314	585,746
Dry Fork Cheyenne River	0	67,232	242,084	309,316
Upper Cheyenne River	0	1,502	142,945	144,447
Lightning Creek	0	49,550	258,772	308,321
Upper Belle Fourche River	0	7,954	425,023	432,977
Middle North Platte River	0	64,082	148,492	212,573
Total	**127,818**	**3,831,786**	**3,241,722**	**7,201,326**

Source: BLM 2003a.

Table 2.4-6
Existing Disturbance to Mule Deer Ranges by Subwatershed
(acres)

Subwatershed	Spring, Summer, Fall	Winter Yearlong	Yearlong	Total
Little Bighorn River	0	17	47	64
Upper Tongue River	0	3,021	409	3,430
Middle Fork Powder River	0	232	27	259
North Fork Powder River	0	0	0	0
Upper Powder River	0	6,372	4,975	11,347
South Fork Powder River	0	177	135	312
Salt Creek	0	463	345	808
Crazy Woman Creek	0	284	211	495
Clear Creek	0	1,533	2,872	4,405
Middle Powder River	0	1,666	630	2,296
Little Powder River	0	5,900	5,408	11,308
Little Missouri River	0	162	1	163
Antelope Creek	0	3,632	13,034	16,666
Dry Fork Cheyenne River	0	453	1,231	1,684
Upper Cheyenne River	0	2	5,879	5,881
Lightning Creek	0	573	2,327	2,900
Upper Belle Fourche River	0	65	15,342	15,407
Middle North Platte River	0	224	336	560
Total	**0**	**24,776**	**53,209**	**77,985**

Source: ENSR 2005b.

SHERIDAN COUNTY

CAMPBELL COUNTY

JOHNSON COUNTY

CONVERSE COUNTY

DAYTON

SHERIDAN

BUFFALO

GILLETTE

WRIGHT

KAYCEE

Burlington Northern RR

Union Pacific RR

PP&L RR

I-90

I-25

14

16

14/16

59

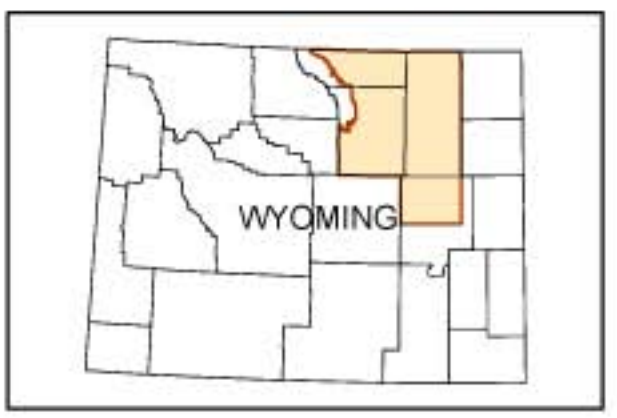
387

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad
- Fortification Creek Herd Unit Boundary

Elk Ranges

- Crucial Winter
- Crucial Winter Yearlong
- Spring, Summer, Fall
- Winter
- Winter Yearlong
- Yearlong
- Parturition



N W E S

0 5 10 15 Miles

0 5 10 15 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company

Powder River Basin Coal Review

Figure 2.4-4

Elk Ranges

6/3/05

Table 2.4-7
Distribution of Elk Ranges by Subwatershed
(acres)

Subwatershed	Crucial Winter	Crucial Winter Yearlong	Spring, Summer, Fall	Winter	Winter Yearlong	Yearlong	Parturitian	Total
Little Bighorn River	4,734	266	1,752	33	2,563	0	0	9,347
Upper Tongue River	26,992	0	10,265	842	10	0	0	38,109
Middle Fork Powder River	0	88,622	43,725	0	745	85,916	0	219,009
North Fork Powder River	0	0	8,489	0	0	12,185	0	20,674
Upper Powder River	0	0	0	0	0	15,345	0	15,345
Upper Powder River-Fortification Creek Herd Unit[1]	38,234	0	0	0	17,123	122,930	59,291	122,930[2]
South Fork Powder River	0	0	0	0	0	16,929	0	16,929
Salt Creek	0	0	0	0	0	19,303	0	19,303
Crazy Woman Creek	0	16,039	34,759	1,616	10,170	0	0	62,585
Clear Creek	9,980	0	6,416	9,349	0	0	0	25,745
Middle Powder River	0	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	0	0	0	0
Little Missouri River	0	0	0	0	0	0	0	0
Antelope Creek	3,401	0	0	0	21,472	61,188	0	86,060
Dry Fork Cheyenne River	0	0	0	0	597	4,339	0	4,936
Upper Cheyenne River	3,390	0	0	0	9,699	68,814	0	81,903
Lightning Creek	0	0	0	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0	10,466	0	10,466
Middle North Platte River	0	0	0	0	0	0	0	0
Total	**86,730**	**104,927**	**105,406**	**11,840**	**116,379**	**417,415**	**59,291**	**733,342[2]**

[1]The entire Fortification Creek herd unit is within the Upper Powder River subwatershed.

[2] Due to the overlap in the designated ranges for the Fortification Creek herd unit, the sum of the acreages for the individual designated ranges is greater than the actual areal extent of designated range within the Fortification Creek herd unit. The total reflects the areal extent of the range.

Source: BLM 2003a; ENSR 2005b.

Table 2.4-8
Existing Disturbance to Elk Ranges by Subwatershed
(acres)

Subwatershed	Crucial Winter	Crucial Winter Yearlong	Spring, Summer, Fall	Winter	Winter Yearlong	Yearlong	Parturitian	Total
Little Bighorn River	0	0	0	0	0	0	0	0
Upper Tongue River	0	0	0	0	0	0	0	0
Middle Fork Powder River	0	0	0	0	0	0	0	0
North Fork Powder River	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	84	0	84
Upper Powder River-Fortification Creek Herd Unit[1]	21	0	0	0	86	399	89	399[2]
South Fork Powder River	0	0	0	0	0	151	0	151
Salt Creek	0	0	0	0	0	30	0	14
Crazy Woman Creek	0	0	0	0	0	0	0	0
Clear Creek	0	0	0	0	0	0	0	0
Middle Powder River	0	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	0	0	0	0
Little Missouri River	0	0	0	0	0	0	0	0
Antelope Creek	20	0	0	0	273	291	0	584
Dry Fork Cheyenne River	0	0	0	0	<1	0	0	<1
Upper Cheyenne River	42	0	0	0	257	1,307	0	1,606
Lightning Creek	0	0	0	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0	0	0	0
Middle North Platte River	0	0	0	0	0	0	0	0
Total	**83**	**0**	**0**	**0**	**616**	**2,111**	**89**	**2,687[2]**

[1]The entire Fortification Creek herd unit is within the Upper Powder River subwatershed.

[2] Due to the overlap in the designated ranges for the Fortification Creek herd unit, the sum of the acreages for the individual designated ranges is greater than the actual areal extent of designated range within the Fortification Creek herd unit. The total reflects the areal extent of the range.

Source: ENSR 2005b.

Moose. Moose typically inhabit forested riparian, shrubby riparian, and wet meadow vegetation types. Moose generally adhere to a specific home range, although they may migrate seasonally in search of forage and habitat. Mortality is commonly due to hunting, starvation, and predation.

There is little suitable moose habitat within the PRB study area. Based on seasonal range maps from the WGFD, moose primarily are restricted to areas along the study area's western boundary in the Big Horn Mountains (**Figure 2.4-5**). The type and distribution of moose ranges by subwatershed are presented in **Table 2.4-9**. There currently are no existing disturbances to moose habitat associated with energy development, agriculture, or urban development within the study area.

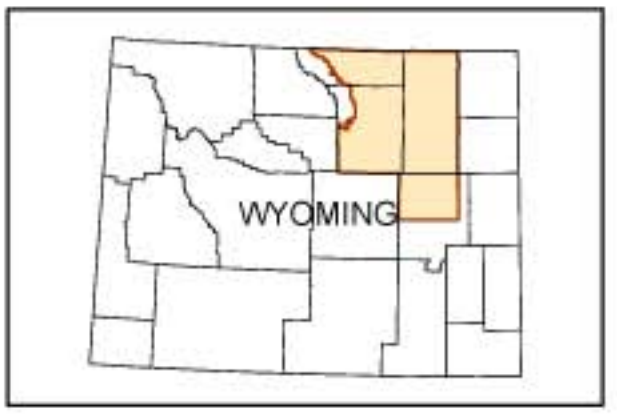
SHERIDAN COUNTY
CAMPBELL COUNTY
JOHNSON COUNTY
CONVERSE COUNTY
DAYTON
SHERIDAN
BUFFALO
GILLETTE
WRIGHT
KAYCEE
Burlington Northern RR
Union Pacific RR
PP&L RR
I-90
I-25
14
16
14/16
59
387

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

Moose Ranges

- Crucial Winter Yearlong
- Crucial Yearlong
- Winter Yearlong
- Yearlong



N
W
E
S

0 5 10 15 Miles

0 5 10 15 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company

Powder River Basin Coal Review

Figure 2.4-5

Moose Ranges

6/20/05

Table 2.4-9
Distribution of Moose Ranges by Subwatershed
(acres)

Subwatershed	Crucial Winter Yearlong	Crucial Yearlong	Winter Yearlong	Yearlong	Total
Little Bighorn River	0	0	0	4,523	4,523
Upper Tongue River	10,123	1,493	15,983	23,266	50,865
Middle Fork Powder River	0	0	0	0	0
North Fork Powder River	0	0	0	0	0
Upper Powder River	0	0	0	0	0
South Fork Powder River	0	0	0	0	0
Salt Creek	0	0	0	0	0
Crazy Woman Creek	0	0	0	4,770	4,770
Clear Creek	0	0	3,554	1,942	5,496
Middle Powder River	0	0	0	0	0
Little Powder River	0	0	0	0	0
Little Missouri River	0	0	0	0	0
Antelope Creek	0	0	0	0	0
Dry Fork Cheyenne River	0	0	0	0	0
Upper Cheyenne River	0	0	0	0	0
Lightning Creek	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0
Middle North Platte River	0	0	0	0	0
Total	**10,123**	**1,493**	**19,537**	**34,501**	**65,654**

Source: BLM 2003a.

Raptors

There are several raptor species that have the potential to occur within the PRB study area. These include: northern harrier, golden eagle, red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk, ferruginous hawk, American kestrel (*Falco sparverius*), prairie falcon, short-eared owl, and great horned owl (*Bubo virginianus*). Both the bald eagle and rough-legged hawk (*Buteo lagopus*) are common winter residents in the study area. Less common raptors in the study area include: osprey, merlin, and burrowing owl (*Athene cunicularia*). Special status raptor species (osprey, bald eagle, ferruginous hawk, merlin, and burrowing owl) are discussed in Section 4.4.3.5, Special Status Species. Habitat is relatively limited for raptor species that nest exclusively in trees or on cliffs. As a result of resource development, some nests have been relocated for mitigation or removed by mining activities. To compensate for the latter, nests have been created to mitigate other impacted nest sites.

Habitat fragmentation effects for raptors is discussed in Section 2.4.3.2, Habitat Fragmentation.

Transmission lines and electrical distribution lines can pose collision and electrocution hazards for raptors. Collision potential is dependent on variables such as habitat types, line orientation to migratory flyways and foraging flight patterns, numbers of migratory and resident bird species, species' characteristics, area familiarity, visibility, types of disturbance, and line design (Beaulaurier et al. 1982; Anderson 1978). However, collision for raptor species is infrequently reported due to their slow flight (often soaring or hovering) and high maneuverability (Avian Power Line Interaction

Committee [APLIC] 1994). Most bird electrocutions occur on distribution systems at lower voltages with a conductor spacing of 2 to 6 feet rather than higher voltage transmission lines. Due to their body size and wingspan, raptors and other large birds are big enough to span the distance between the conducts on these systems, completing an electrical circuit (APLIC 1996).

At two surface mines in the PRB, raptor populations were monitored in order to determine the extent of raptor occurrence (Seacross 2002). Results showed that annual raptor nesting density in these areas ranged from 2.8 to 4.6 square miles per breeding pair. The total density of all nests was found to be one per square mile (Seacross 2002). Based on these results, it is estimated that the PRB study area yields 2,690 to 4,410 active nests annually, with a total count of 12,360 nests (active and inactive).

Northern Harrier. This species is relatively widespread throughout North America, with densities being the greatest in prairie habitats. Nesting habitat for this species includes native and non-native grasslands, agricultural lands, emergent wetland marshes, and mountain sagebrush (Carter 1998a). The Northern harrier is a common summer resident in Wyoming (Luce et al. 1999). Very little population data are available; however, at one coal mine in Campbell County, up to four breeding pairs have been documented, depending on the year (Seacross 2002). Based on this data, there potentially could be as many as 250 breeding pairs in the PRB study area.

Golden Eagle. In North America, the golden eagle inhabits the mountain and grassland regions where medium-sized mammals are abundant (Glinski 1998). The species is classified as a common year-round resident in Wyoming. Foraging habitat includes grasslands, sagebrush, and farmlands (Barrett 1998a). This species nests on open cliffs or in larger trees. Past studies conducted in the PRB estimate that there are between 500 and 630 breeding pairs in the PRB study area (Phillips et al. 1984; Seacross 2002).

Red-tailed Hawk. The Red-tailed hawk uses a variety of habitats and range from Alaska south to Panama and east to Nova Scotia and the Virgin Islands (Preston 1998b). In Wyoming, this species is considered a year-round resident common to most habitats below 9,000 feet amsl, occupying prairie grassland, riparian, sagebrush, and piñon/juniper woodland habitats (Luce et al. 1999). Typical nest sites include trees and cliffs. This species is more tolerant of human activities than are other raptors. The density of nesting pairs varies from one pair per 10 to 20 square miles (Seacross 2002), depending on the availability of suitable nest sites. Based on these densities, breeding populations in the PRB study area potentially could range between 620 and 1,240 pairs.

Swainson's Hawk. The Swainson's hawk breeds in North America and winters in South America. In Wyoming, this species is considered a summer resident common to grasslands below 9,000 feet amsl (Luce et al. 1999). Concern for this species throughout its range has increased following reports of substantial habitat loss and exposure to pesticides on wintering grounds in South America. The Swainson's hawk is relatively sensitive to human disturbance near active nests. Breeding pairs construct nests in the tops of isolated trees or use nests built by magpies, crows, ravens, or other hawks (Preston 1998c). The reported density of nesting pairs varies from as high as one pair per 3.7 square miles where prey are abundant to as low as one pair per 40 square miles (Seacross 2002). Based on these densities, the number of breeding pairs in the study area has been estimated to range between 310 and 3,340, and is most likely between 1,000 and 2,000.

Rough-legged Hawk. The rough-legged hawk occurs in the northern latitudes of Canada during the summer and in the U.S. from California east to Maine in the winter. In Wyoming, where this species is considered a common winter resident (Luce et al. 1999), the rough-legged hawk occurs in short grass and mixed-grass prairies and sagebrush and other shrublands. No population estimate has been made for this species, because most raptor surveys occur during the breeding season when rough-legged hawks are not present in the study area. The number of wintering hawks in a particular area is highly variable from year to year, depending on weather conditions and availability of prey (Ehrlich et al. 1988).

American Kestrel. The American kestrel is found throughout North and South America from Alaska south to the southernmost tip of South America. This species is known to breed in every state of the U.S., except Hawaii, and each province of Canada. American kestrels prefer open country with sufficient perches (e.g., dead trees, rock outcrops, utility poles, and wires) for hunting (Winn 1998a). Nest sites often include tree cavities, crevices, cliffs, and nest boxes. In Wyoming, the kestrel is a very common summer resident in suitable habitats below 8,500 feet amsl. No attempts have been made to estimate the population density of kestrels in the PRB study area (Seacross 2002).

Prairie Falcon. The prairie falcon ranges over the western half of North America from southern Alberta, Saskatchewan, and British Columbia south to central Mexico (Jones 1998c). In Wyoming, the prairie falcon is considered a common resident, nesting in cliff habitats in open areas (Luce et al. 1999). Where suitable nesting habitat is available, such as at the Pumpkin Buttes in the study area, several pairs can be found in close proximity. No estimate of population density in the PRB study area has been made because of the scattered and uncommon nature of prairie falcon nesting sites.

Short-eared Owl. The short-eared owl occurs throughout Canada and the central and northern U.S. In Wyoming, this species is a common year-round resident (Luce et al. 1999). This owl is a ground-nesting species, in short- and mixed-grass prairies and herbaceous wetlands (Boyle 1998a). The density of nesting short-eared owl pairs appears to be highly variable and is based on the abundance of prey species (Seacross 2002). No population estimate has been made for the PRB study area because of the species' variability in occurrence and lack of data.

Great Horned Owl. The great horned owl occurs from the northern edge of the boreal forest in Alaska and Canada to the southern tip of South America. This owl typically nests in wooded areas adjacent to open spaces such as shrublands, grasslands, and farm fields that provide a sufficient prey base (Boyle 1998b). In Wyoming, this owl is considered a common resident of most habitats below 9,000 feet amsl, especially in riparian areas dominated by cottonwood (Luce et al. 1999). Great horned owls are tolerant of human activities and nest in a variety of structures, including industrial facilities. The nesting density of this owl varies from 18.5 to 40 square miles per breeding pair, although the secretive nature of the species makes nest detection difficult (Seacross 2002). Based on this density, an estimated 310 to 670 breeding pairs may occur in the PRB study area.

Upland Game Birds

Several species of upland game birds may occur within the PRB study area, including ring-necked pheasant (*Phasianus colchicus*), gray partridge (*Perdix perdix*), wild turkey (*Meleagris gallopavo*), mourning dove (*Zenaida macroura*), greater sage-grouse (*Centrocercus urophasianus*), and sharp-tailed grouse (*Tympanuchus phasianellus*) (Luce et al. 1999). The greater sage-grouse is

discussed in detail in Section 2.4.3.5, Special Status Species. Mourning doves are abundant in a variety of habitats that occur in the study area. Both the gray partridge and ring-necked pheasant occur locally near agricultural lands and along river bottomland. Wild turkeys occur locally in ponderosa pine and shrubby or forested riparian areas. None of these species is specifically monitored or managed other than through normal hunting seasons.

The sharp-tailed grouse occurs on a variety of habitats including short- and mixed-grass prairie, sagebrush shrublands, woodland edges, and river canyons. In Wyoming, this species is locally common where grasslands are intermixed with other shrublands, especially in wooded draws, shrubby riparian areas, and wet meadows (Luce et al. 1999). Species of shrubs that produce berries (such as chokecherry and Russian olive) provide important winter forage for sharp-tailed grouse. Leks typically are located on hilltops, ridges, or other high points in low, open grassland habitats.

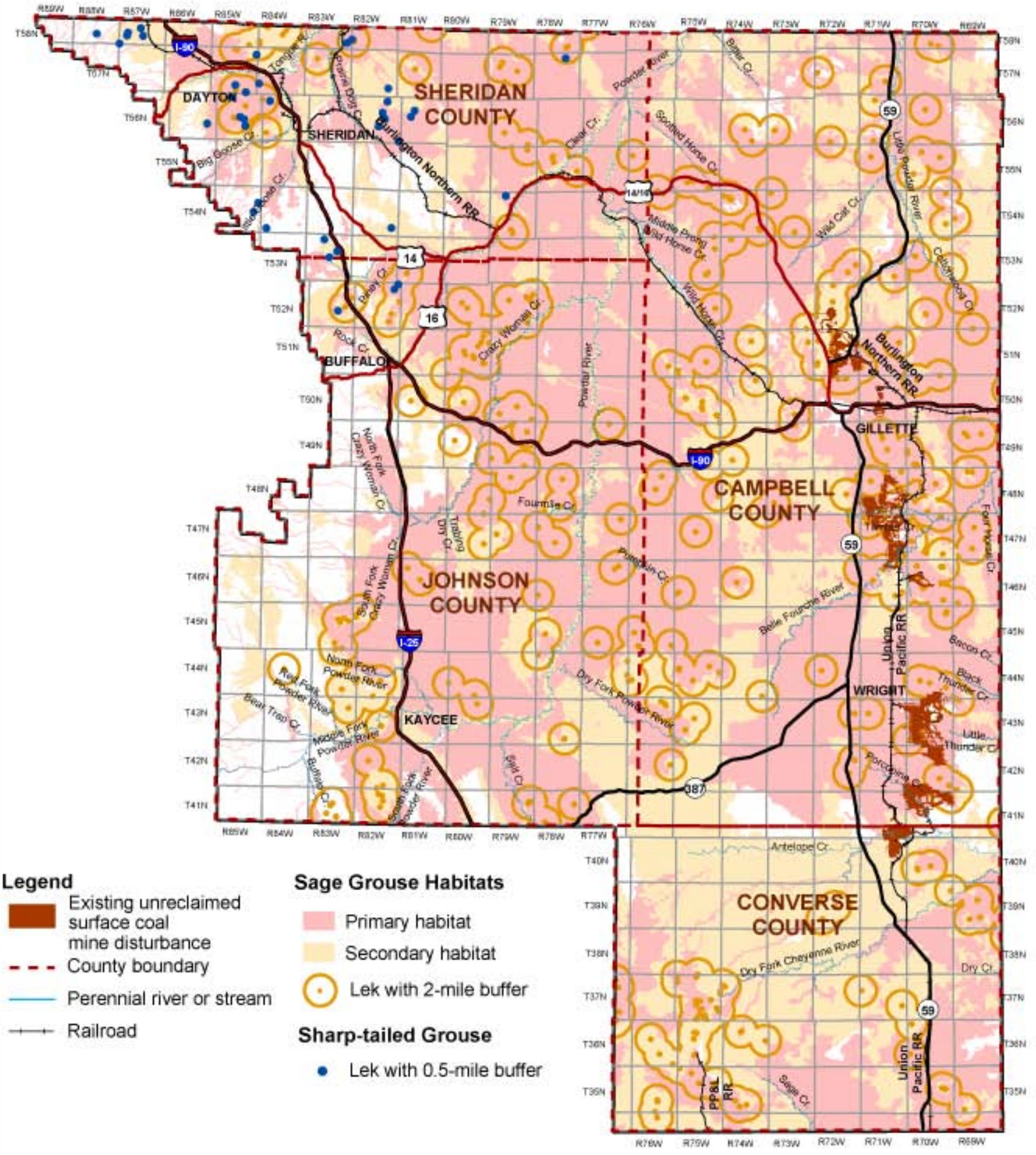
Data provided by the WGFD indicate that plains sharp-tailed grouse leks occur primarily in the northern portion of the PRB study area, where its preferred habitats are most common. However, the WGFD data for Johnson County is incomplete (no data reported south of I-90). Based on existing data, there are 40 documented lek sites in the study area. **Figure 2.4-6** shows the distribution of potentially suitable sharp-tailed grouse habitats in the PRB study area. Past surveys have not covered the entire PRB study area because of the amount of private land present; therefore, the actual number of leks may be higher. No estimate has been made of sharp-tailed grouse populations in the study area.

As a result of past and continuing human activities in the PRB study area, substantial areas of sharp-tailed grouse habitat have been altered from their natural conditions. Human disturbances include, but are not limited to, agriculture, mining, roads, urban areas, oil and gas well pads, compressor sites, and other ancillary facilities. **Table 2.4-10** presents the number of sharp-tailed grouse leks with existing disturbance within their protective buffers by subwatershed.

Waterfowl

Suitable waterfowl habitats within the PRB study area include major rivers, streams, creeks, draws, lakes, and ponds. These features provide stopover habitats for migrating waterfowl in the spring and fall as well as breeding habitats in the summer months. Waterfowl species that can be expected to occur in the study area include Canada goose (*Branta canadensis*), wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), gadwall (*Anas strepera*), green-winged teal (*Anas crecca*), American widgeon (*Anas americana*), northern pintail (*Anas acuta*), northern shoveler (*Anas clypeata*), blue-winged teal (*Anas discors*), cinnamon teal (*Anas cyanoptera*), canvasback (*Aythya valisineria*), and redhead (*Aythya americana*). Several wading birds and shorebirds also use similar habitats in the study area, including great blue heron (*Ardea herodias*), killdeer (*Charadrius vociferus*), American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*), spotted sandpiper (*Actitis macularia*), and Wilson's phalarope (*Phalaropus tricolor*) (National Geographic 1999).

The occurrence and distribution of these species are variable and influenced by local conditions such as aquatic habitat, adjacent upland habitat, season, and land use practices. These waterfowl species are expected to occur in suitable habitats within the PRB study area during the appropriate



Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

Sage Grouse Habitats

- Primary habitat
- Secondary habitat
- Lek with 2-mile buffer

Sharp-tailed Grouse

- Lek with 0.5-mile buffer

N W E S

0 5 10 15 Miles

0 5 10 15 Kilometers

Powder River Basin Coal Review

Figure 2.4-6
Sage Grouse Lek Sites and Habitats, and Sharp-tailed Grouse Lek Sites

Source: BLM 2003a, 2004; Christiansen 2005; Thunder Basin Coal Company 2003

6/20/05

Table 2.4-10
Sharp-tailed Grouse Lek Sites, Protective Buffers, and Existing Impacts to Protective Buffers by Subwatershed

Subwatershed	Total Number of Leks	Number of Lek Sites With Development-related Disturbance Within the 0.5-mile Buffer
Little Bighorn River	6	2
Upper Tongue River	27	4
Middle Fork Powder River	0	0
North Fork Powder River	0	0
Upper Powder River	0	0
South Fork Powder River	0	0
Salt Creek	0	0
Crazy Woman Creek	0	0
Clear Creek	7	3
Middle Powder River	0	0
Little Powder River	0	0
Little Missouri River	0	0
Antelope Creek	0	0
Dry Fork Cheyenne River	0	0
Upper Cheyenne River	0	0
Lightning Creek	0	0
Upper Belle Fourche River	0	0
Middle North Platte River	0	0
Total	**40**	**9**

Source: ENSR 2005b.

species-specific nesting, migration, and wintering seasons. No estimates of population size within the study area are available for any of these species.

There is no existing information on the specific impacts of existing oil and gas development on waterfowl. Existing impacts that may have occurred also are related to the various methods of CBNG water handling. At present, much of the CBNG produced water is discharged to surface drainages. Approximately 73,000 acre-feet per year of CBNG discharge have been permitted in the study area as of the year 2003 (WOGCC 2004). Although much of this water evaporates or infiltrates, substantial quantities remain on the surface and have resulted in the expansion of wetlands, stock ponds, and reservoirs, potentially increasing waterfowl breeding and foraging habitats. Produced water in some parts of the study area is disposed of in containment reservoirs, which also may provide waterfowl habitats, although in many cases appropriate vegetative cover and foraging areas have not developed around these reservoirs. It is possible for salts to accumulate in some CBNG water containment reservoirs. As water evaporates, salinity increases and may result in mass production of salt tolerant invertebrates such as brine shrimp, a major food source attractive to birds (Pennak 1989; Tribbey 1988). Waterfowl mortalities resulting from salt crystallization and/or toxicity have been documented in hypersaline wetlands in North Dakota and California, where sodium concentrations exceeding 17,000 mg/L were reported and alternative freshwater sources were not available nearby (Gordus et al. 2002; Windingstad et al. 1987). Similarly, in Canada, lake concentrations of sodium in excess of 30,900 mg/L were reported to cause mortality in some Canada geese. Moving salt-stressed geese to freshwater resulted in full recovery (Wobeser and Howard 1987).

The median sodium concentration of Fort Union Formation CBNG produced water is 270 mg/L (BLM 2003a). If sodium concentrations are maintained below 17,000 mg/L in the evaporation ponds, the potential for adverse effects to waterfowl would be minimal. Further, presence of freshwater sources within the study area, including the Upper Tongue River; Upper, Middle, and Little Powder Rivers; and Crazy Woman Creek, would decrease the potential for sodium toxicity to migratory waterfowl (Kantrud and Stewart 1977; Swanson et al. 1983).

Neotropical Migrant Birds

Neotropical migrants are birds that migrate long distances from wintering grounds in the tropics of Central and South America to breeding grounds in North America. A wide variety of neotropical migrants use the PRB study area during migration or the breeding season. All habitat types in the study area potentially are used by these species; the highest level of use by the most species occurs in the more productive and diverse habitats (e.g., forested riparian areas). Shrub-steppe habitats (sagebrush shrublands and other shrublands in part) and short grass prairie habitats are both common in the PRB study area and are of critical importance to some neotropical migrants (Rothwell 1992). Many species that are of high concern to management because of declining populations use shrub-steppe and short grass prairie as their primary breeding habitats (Saab and Rich 1997).

In response to concerns about neotropical migrants, the Wyoming Bird Conservation Plan (Cerovski et al. 2001) has identified two groups of high-priority species in Wyoming. **Table 2.4-11** lists the migratory bird species of management concern in Wyoming (Nicholoff 2003) that are known or expected to occur in the study area (Luce et al. 1999). Level I species are those that require conservation action. They include species for which Wyoming has a high percentage of, and responsibility for, the breeding population. Fifteen other Level I species not included in **Table 2.4-11** are discussed in Section 2.4.3.5, Special Status Species. The focus for Level II species is monitoring, rather than active conservation. Eight other Level II species not included in **Table 2.4-11** are discussed in Section 2.4.3.5, Special Status Species. Level III species are of local interest but do not require conservation action or monitoring (Nicholoff 2003); these species are not discussed in this document.

Few data are available on population numbers of these species; however, Breeding Bird Survey (BBS) data (Sauer et al. 2001) can be used to determine population trends in a geographic area. There are approximately 15 active BBS routes, as well as data available from two discontinued routes, in the PRB study area (Cerovski et al. 2001). This number is too few to support statistically valid estimates of population; however, trends for the State of Wyoming and the U.S. are shown in **Table 2.4-11**. Even at the state scale, estimates for many species are not statistically robust (Sauer et al. 2001). Likewise, little data on existing impacts from oil and gas development are available. However, much of the recent energy development is too recent to have had a measurable effect on populations of migratory birds. Loss and degradation of habitats has likely occurred, as has disturbance to individual birds resulting from construction and production activities. In areas of concentrated development, breeding density of some species may have been reduced because of these and other effects. Species that are specific to grassland and shrub-steppe habitats, and that are sensitive to disturbance and habitat fragmentation likely have been the most affected.

Table 2.4-11
Migratory Bird Species of Management Concern in Wyoming

Species	Habitats[1]	Comments[2]	Breading Bird Survey Trend[3]
Level I Species			
McCown's Longspur	Short grass prairie, shrub-steppe, eastern great plains and great basin-foothills grasslands, basin-prairie shrublands, agricultural areas.	Nests in a shallow natural or scraped depression on the ground. Feeds on seeds, insects.	WY: Increase – S[4] US: Increase - NS
Wilson's Phalarope	Wetlands, marshes, lakes, shorelines.	Nests in a lined scrape on damp ground near water. Feeds mostly on aquatic invertebrates, seeds of aquatic plants.	WY: Decrease – NS[4] US: Decrease - S
Level II Species			
Cassin's Kingbird	Juniper woodlands, plains/basin riparian, ponderosa pine savannah, pine-juniper, cottonwood-riparian, cottonwood-dryland, woodland-chaparral, basin-prairie, and mountain-foothills shrublands.	Nests on a horizontal branch near the trunk of a tree. Feeds on insects, berries.	WY: Increase – NS[4] US: Decrease - NS
Lark Bunting	Short grass prairie, shrub-steppe, basin-prairie and mountain-foothills shrublands, eastern great plains and great basin-foothills grasslands, agricultural areas.	Nests on the ground, with the rim of the nest usually flush with the ground. Feeds on insects, especially grasshoppers, seeds.	WY: Stable - NS US: Decrease - S
Dickcissel	Short grass prairie, eastern great plains grasslands.	Nest is bulky, placed in grass. Feeds on insects, seeds.	WY: Increase – NS[4] US: Decrease - S
Chestnut-collared Longspur	Short grass prairie, eastern great plains and great basin-foothills grasslands, basin-prairie shrublands, agricultural areas.	Nests in a shallow depression on the ground, usually concealed by a tuft of grass. Feeds on insects, seeds.	WY: Decrease - NS[4] US: Decrease - NS
Willow Flycatcher	Montane riparian, plains/basin riparian, riparian shrub including willow, hawthorne, water birch, alder, below 9,000 feet amsl.	Nests in an upright or slanting fork in a shrub. Feeds primarily on insects, occasionally berries.	WY: Decrease – NS[4] US: Decrease - NS
Marsh Wren	Wetlands, marshes, drier habitats during migration.	Nest is attached to reeds. Feeds on insects, snails. Abundant in some areas.	WY: Decrease – NS[4] US: Increase - S
Western Bluebird	Juniper woodland, low elevation conifer, pine-juniper, juniper woodlands, associated with edges.	Often nests in a woodpecker excavated cavity in a snag. Feeds on insects, fruit, some invertebrates.	WY: No trend data available US: Decrease - NS
Grasshopper Sparrow	Short grass prairie, shrub-steppe, basin-prairie shrublands, eastern great plains grasslands, wet-moist meadow grasslands, agricultural areas.	Nest is sunk in a slight depression on the ground. Feeds on insects, seeds.	WY: Decrease – NS[4] US: Decrease - S
Bobolink	Short grass prairie, shrub-steppe, basin-prairie shrublands, eastern great plains grasslands, great basin-foothills grasslands, alfalfa, irrigated and native introduced meadows.	Nests in dense cover of forbs in a natural or scraped depression on the ground. Feeds primarily on insects, seeds.	WY: Increase – S[4] US: Decrease - S
Black-billed Cuckoo	Plains/basin riparian, deciduous and mixed deciduous/coniferous forests, open woodlands, especially cottonwood-riparian, urban areas.	Nest is placed horizontally against a tree trunk, also on a log, occasionally in vine tangles. Feeds primarily on hairy caterpillars, also mollusks, fish, small vertebrates, berries.	WY: Decrease – NS[4] US: Decrease - S
Vesper Sparrow	Shrub-steppe, basin-prairie and mountain-foothills shrublands, grasslands, agricultural areas.	Nests in an excavated depression on the ground. Food is 50 percent insects, 50 percent grass and forb seeds.	WY: Decrease – NS US: Decrease - S
Lark Sparrow	Shrub-steppe, pine-juniper, woodland-chaparral, basin-prairie and mountain-foothills shrublands, grasslands, agricultural areas.	Nests in a hollow depression on the ground, feeds on seeds, insects.	WY: Decrease – NS US: Decrease - S

[1]From Luce et al. 1999 and Nicholoff 2003.
[2]From Luce et al. 1999.
[3]S: Trend is statistically significant. NS: Trend is not statistically significant. From Sauer et al. 2001.
[4]Data used for this trend estimate have very low species abundance, small sample size, and high variance.

2.4.3.4 Fisheries

The project study area for fisheries consists of perennial streams and standing water environments (ponds, lakes, and reservoirs) within 18 fourth order watersheds (subwatersheds). The subwatersheds are part of eight basins: Powder River, Little Powder River, Tongue River, Cheyenne River, Belle Fourche River, North Platte River, Cheyenne River, Little Bighorn River, and Little Missouri River (**Figure 1-4**). The basin and subwatershed boundaries are based on the U.S. Environmental Protection Agency (USEPA) Watershed Profile for the State of Wyoming (2002). Additional information concerning hydrological characteristics of the subwatersheds is provided in the Task 1 Report for the PRB Coal Review, Water Resources (ENSR 2005).

Published journals, agency records (e.g., USFWS, BLM, WGFD, and Wyoming Natural Diversity Database [WYNDD]), and other available peer-reviewed scientific literature were examined for information on fish species found within the project area subwatersheds. Primary data sources included the Final EIS for the Powder River Basin Oil and Gas Project (BLM 2003a), WGFD's Basin Management Plans, and recent WGFD Annual Fisheries Reports (2001 through 2003).

Fish resources within the project area water bodies include a mixture of coldwater and warmwater species. Species that are managed by the WGFD include game or sports fish and special status species. Seventeen game fish species representing four families (trout, perches, catfishes, and sunfishes/bass) occur in one or more of the project area subwatersheds (**Table 2.4-12**). Habitat and spawning information also is provided in **Table 2.4-12**. Federally listed and WGFD sensitive species are discussed in the Special Status Species subsection below. The following information provides a summary of fish resources in the project area water bodies.

Powder River Basin

The Powder River Basin includes eight subwatersheds: Upper Powder, Salt Creek, Crazy Woman Creek, Clear Creek, Middle Powder River, Middle Fork Powder River, South Fork Powder River, and North Fork Powder River. The number of perennial streams in this basin is limited to portions of the South Fork Powder, Salt Creek, Crazy Woman Creek, and Clear Creek.

The Powder River is a low-gradient meandering stream that contains highly fluctuating flows, high turbidity, and a very unstable sand bottom (Hubert 1993). The river is naturally turbid and saline because of it flows through erodible sedimentary material. Though occasionally the river clears, it is typically very turbid during spring runoff and after storms. The river is generally shallow and contains portions of shifting streambed composed of fine sands and clays that provide minimal habitat for aquatic invertebrates. Low light penetration through the turbid water also contributes to low aquatic invertebrate production by inhibiting vegetation growth (Bradshaw 1996a).

Virtually all of the bottomland and riparian areas of the Powder River Basin are privately owned. Public lands, usually sagebrush or grasslands in uplands adjacent to the river, are managed by the BLM and are concentrated in the Powder River Basin about midway down the Powder River and in the upper reach of the South Fork Powder River (Bradshaw 1996a). Historically, the Powder River Basin was used extensively and almost exclusively for cattle and sheep grazing. Oil and gas developments and recently developed coal mines have become dominant land uses over the past 80 years (Bradshaw 1996a).

Table 2.4-12
Game Fish Occurrence, Habitat Use, and Spawning

Species	Subwatershed Occurrence	Habitat	Spawning Period
Trout			
Rainbow trout	Little Bighorn, Upper Tongue, and Little Powder	Inhabits both streams and lake/ponds that are cool and clear.	Spring
Cutthroat trout	Little Bighorn	Prefers cool streams.	Spring
Snake River cutthroat	Upper Tongue	Same as above.	Spring
Yellowstone cutthroat trout	Upper Tongue	Same as above.	Spring
Brown trout	Little Bighorn, Upper Tongue, Middle Fork Powder, and South Fork Powder	Prefers larger foothill streams with slow-moving velocities and an abundance of cover.	Fall
Brook trout	Little Bighorn, Upper Tongue, Middle Fork Powder, South Fork Powder, and Little Powder	Inhabits both stream and pond environments.	Fall
Mountain whitefish	Upper Tongue	Mainly inhabits large, clear rivers and streams in relatively deep and fast currents.	Fall
Perches			
Sauger	Upper Tongue, Upper Powder, and Clear Creek	Prefers relatively large rivers and reservoirs.	Spring
Walleye	Upper Tongue	Inhabits clear, cold reservoirs, lakes, and rivers.	Spring
Yellow perch	Upper Tongue	Inhabits both lakes, reservoirs, ponds, and slow-moving streams.	Spring
Catfishes			
Black bullhead	Upper Tongue, Upper Powder, Middle Powder, Little Powder, Upper Cheyenne, and Upper Belle Fourche	Occurs in ponds, small reservoirs, or pool habitat in streams that are often turbid.	Late spring/early summer
Channel catfish	Upper Tongue, Upper Powder, Crazy Woman Creek, Middle Powder, and Little Powder	Inhabits streams, rivers, reservoirs, and lakes in both clear and turbid waters.	Late spring/early summer
Bass and Sunfishes			
Largemouth bass	Little Powder	Prefers larger lakes and backwaters of slow-moving streams or rivers with an abundance of cover.	Spring
Smallmouth bass	Upper Tongue and Clear Creek	Prefers cool, clear rivers or lakes.	Spring
Rock bass	Upper Tongue, Upper Powder, and Clear Creek	Inhabits pool habitat in streams with cobble-dominated substrate.	Late spring/early summer
White crappie	Upper Tongue	Prefers larger ponds, reservoirs, and rivers with an abundance of woody debris or aquatic vegetation.	Late spring/early summer
Green sunfish	Upper Tongue, Middle Powder, Little Powder, Upper Cheyenne, and Upper Belle Fourche	Inhabits small to medium-sized streams, small lakes, ponds, and sloughs.	Late spring/early summer

Sources: Baxter and Simon 1970; Woodling 1985.

The Powder River and its tributaries support 28 known fish species of which 20 are native. Most of these species are tolerant of widely fluctuating environmental conditions, such as turbidity, salinity, and water temperature. The common species in the river include flathead chub, sturgeon chub, goldeye, river carpsucker, stonecat, common carp, longnose dace, and channel catfish (Appendix B, **Table B-1**) (Hubert 1993). The game species in the Powder River and its tributaries include black bullhead, channel catfish, stonecat, smallmouth bass, rock bass, green sunfish, sauger, and walleye (**Table 2.4-12**) (Hubert 1993). Trout species such as brook trout and brown trout are found in the headwaters of the South Fork Powder River, Middle Fork Powder River, North Fork Powder River, Upper Powder River, Salt Creek, Crazy Woman Creek, Willow Creek, and Sanchez Creek.

Smith and Hubert (1989) divided the Powder River and Crazy Woman Creek fisheries into four groups: creek residents, creek-river migrants, river residents, and creek-river residents. Creek residents included residents found only in Crazy Woman Creek such as fathead minnow, white sucker, and longnose sucker. River residents occurred only in the Powder River and included shovelnose sturgeon, sturgeon chub, burbot, and sauger. Creek-river residents occurred at all life stages and in all seasons in both the creek and river. These residents included flathead chub longnose dace, sand shiner, stonecat, and walleye. Creek-river migrants move into Crazy Woman Creek from the Powder River to spawn and then return to the river before summer periods of low discharge. They include goldeye, common carp, river carpsucker, and channel catfish (Smith and Hubert 1989).

Standing waters in the Powder River Basin mainly consist of relatively small (less than 10 acres) reservoirs and farm ponds. Various trout species, channel catfish, and largemouth bass are the primary stocked species. Since 1995, most of the stocking has been done by private landowners.

Little Powder River Basin

The Little Powder River Drainage Basin contains the entire Little Powder River subwatershed. Flowing water in this basin is restricted to three stream reaches, all of which are on private land. The Little Powder River and a short reach of the Dry Fork of the Little Powder River below its confluence with Moyer Springs Creek are perennial. The only coldwater habitat in the drainage is Moyer Springs Creek, a 0.5-mile reach of stream that contains a wild brook trout population with flows usually less than 1 cubic foot per second. There is no perennial water in any of the other tributary streams in the drainage. Only one small standing lake, Weston Reservoir (Little Powder Reservoir) is suitable for game fish and is on accessible public land (Stewart 1996). Warmwater game fish species that occur in stream segments with more persistent flow include brown bullhead, channel catfish, green sunfish, and largemouth bass. Fish numbers are limited to the relatively small size of the stream segments and low water levels. Other nongame species in this basin are listed in Appendix B, **Table B-1**.

Tongue River Basin

The Upper Tongue River is the only subwatershed in the Tongue River Basin that is located in the project study area. The types of water bodies in the Upper Tongue River consist of headwater tributary streams, mainstem portion of the Upper Tongue River, and privately owned ponds. Habitat quality varies throughout the subwatershed. Although coldwater habitat is provided in the headwater tributaries, an absence or scarcity of deep pools in some of the streams limits the

development of larger fish (Stewart 1995). Irrigation diversions reduce flows on many streams and form barriers downstream of I-90 that impede seasonal upstream fish movements.

Game fish species include the Snake River cutthroat trout, Yellowstone cutthroat trout, rainbow, brown, and brook trout, which inhabit headwater tributaries. Yellowstone cutthroat trout, which is the only native trout species in the basin, is limited to isolated headwater tributaries. The lower portion of the Upper Tongue River also supports sauger and smallmouth bass (Stewart 1995). Some of the ponds contain warmwater game species such as brown bullhead, channel catfish, green sunfish, white crappie, and rock bass. Other nongame fish species known to occur in the subwatershed are listed in Appendix B, **Table B-1**.

During the past few years Yellowstone cutthroat trout and Snake River cutthroat trout were stocked in Bull Creek and the North Tongue River (WGFD 2003). Based on sampling in the Experimental Pastures Area adjacent to the North Tongue River, trout population estimates (number of fish/mile) were brook trout (148), brown trout (8), rainbow trout (963), rainbow/cutthroat hybrids (1,227), Snake River cutthroat trout (334), and Yellowstone cutthroat trout (15) (WGFD 2003).

Wolfe Creek, a tributary to the Tongue River, also supports brown, rainbow, and brook trout. Several miles of Wolfe Creek are protected by a conservation agreement. This easement represents a potential restoration area for Yellowstone cutthroat trout.

Belle Fourche River Basin

The Upper Belle River sub-watershed, which is part of the Belle Fourche River Basin, is located within the project study area. Most of the streams in this subwatershed are unsuitable for coldwater fish due to higher water temperatures. None of the streams located in the Upper Belle Fourche subwatershed support self-sustaining trout populations. Habitat for warmwater fish also is limited as a result of water diversions and relatively small size of the water bodies (McDowell 1996a). Private farm ponds and reservoirs represent the primary type of warmwater habitat. Limited information is available for fish occurrence in the privately-owned water bodies. Game fish species likely inhabiting many of the ponds and reservoirs include black bullhead and green sunfish (McDowell 1996a). The Belle Fourche River below Keyhole Reservoir is dominated by native nongame fish species but also contains game species such as channel catfish and smallmouth bass.

Cheyenne River Basin

Subwatersheds in the Cheyenne River Basin include Antelope Creek, Upper Cheyenne River, Dry Fork Cheyenne River, and Lightening Creek. Approximately 45 percent of the basin is located on public land managed by the BLM, USFS, or the State Land and Farm Loan Office (Bradshaw 1996b). However, most of the bottomland and riparian areas of the Cheyenne River are privately owned. Streams in these subwatersheds are considered unsuitable by the WGFD as a result of intermittent flows and relatively high summer water temperatures. Standing waters in the basin consist of reservoirs and ponds, most of which are less than 10 surface acres. WGFD stocks privately owned farm ponds based on their potential to support game fish species and access to public fishing. Limited information is available regarding fish occurrence in the Cheyenne River Basin. However, green sunfish and black bullhead are known to be abundant in some water bodies (Bradshaw 1996b). Channel catfish and largemouth bass may be present in low numbers in some water bodies. Native nongame fish species in the basin are listed in Appendix B, **Table B-1**.

North Platte River – Pine Ridge to Nebraska Basin

The Middle North Platte Casper subwatershed is contained within a small portion of this basin (northwest corner) and includes watercourses such as Sage Creek and Sand Creek. The area on the north side of the North Platte River is arid with typical plains streams (Deromedi 1996). The streams within this basin are generally small and flows are intermittent or low throughout the year (Deromedi 1996). They flow through low-gradient sandy and silty soils that are generally not suitable habitat for game fish species. Because fishing pressure is low and access is limited, no trout have been stocked in this basin for many years (Deromedi 1996).

Little Bighorn River Basin

The Little Bighorn subwatershed is located within the northern portion of the basin and northwest portion of the project study area. Within the project study area, this subwatershed contains a few perennial streams such as Elkhorn, Gay, East Pass, West Pass, Twin, and East Twin creeks.

The Little Bighorn River Basin is a tributary to the Yellowstone River and historical range for native Yellowstone cutthroat trout (McDowell 1996b). Because of the remoteness of part of the drainage basin, especially the West Fork of the Little Bighorn River Basin, fishery surveys have been limited and data are lacking to evaluate the presence of endemic populations of Yellowstone cutthroat trout (McDowell 1996b).

Elkhorn Creek enters the Little Bighorn River near the Montana state line. Electrofishing in 1983 collected brook trout and cutthroat trout (McDowell 1996b). Temperature measurements in this stream indicated that it could support Yellowstone cutthroat trout (WGFG 2003).

East Pass and West Pass Creek historically have been stocked with rainbow trout, brook trout, and brown trout. As part of Yellowstone cutthroat management evaluations, trout population surveys were conducted in East Pass and West Pass creeks in 2002. No Yellowstone cutthroat trout were captured in the creeks. However, other trout species were estimated at the following population levels: 2,146 brown trout/mile in West Pass Creek and 1,030 brown trout/mile and 97 rainbow trout/mile in East Pass Creek (WGFD 2003).

Trout habitat is limited in tributaries to East Pass and West Pass creeks. Gay Creek, a tributary to West Pass Creek, may be capable of supporting trout, but none were found during the last recorded survey in 1982 (McDowell 1996b). Flow in Twin Creek, a tributary to East Pass Creek, is insufficient to support trout. Electrofishing surveys conducted in 1958 found small dace, fathead minnows, and numerous suckers and cyprinids (McDowell 1996b).

Little Missouri River

The Little Missouri River is comprised of the Little Missouri subwatershed in northeastern Wyoming. Although some state and federal land is present, no public access is available to flowing water within the basin (McDowell 1996c). The majority of the drainage basin is contained within Crook County except for some very small sections in Campbell County (McDowell 1996c). These small sections within Campbell County contain the Little Missouri River subwatershed within the project study area.

The majority of the drainage basin area is sagebrush and grassland, with ponderosa pine along the ridges and breaks of low rolling hills (McDowell 1996c). Livestock production is the primary land use within the drainage basin. Small stock water ponds and irrigation reservoirs in the Hattie Creek, Switzer Draw, Cracker Creek, and Flat Creek drainages provide the majority of fisheries habitat (McDowell 1996c). WGFD listed the majority of the water bodies in this drainage basin as unsuitable for sustaining a fishery (McDowell 1996c).

2.4.3.5 Special Status Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed and federally proposed species that are protected under the ESA, or are sensitive species considered candidates for such listing by the USFWS, as well as BLM, USFS, and WGFD sensitive species.

In accordance with the ESA, as amended, land management agencies in coordination with the USFWS must ensure that any action that they authorize, fund, or carry out would not adversely affect a federally listed threatened or endangered species. In addition, as stated in Special Status Species Management Policy 6840 (6840 Policy) (Rel. 6-151), it also is BLM policy "to conserve listed species and the ecosystems on which they depend, and to ensure that actions requiring authorization or approval by the BLM are consistent with the conservation needs of special status species and do not contribute to the need to list any special status species, either under the provisions of the ESA or other provisions" identified in the 6840 Policy.

A total of 2 federally listed species, 22 BLM sensitive species, 29 USFS sensitive species, and 24 WGFD native sensitive species were identified as potentially occurring in the PRB study area. These species, as well as two other federally listed or federal candidate species, are discussed below.

Federally Listed and Federal Candidate Wildlife Species

In a letter dated June 5, 2001, the USFWS acknowledged that the list of threatened, endangered, or proposed species that may occur within the PRB study area and were included in an earlier letter dated June 5, 2000, are appropriate for evaluation, with the exception of the swift fox, black-tailed prairie dog, and sturgeon chub (USFWS 2001a,b). After the June 5, 2000, letter was drafted, the USFWS announced that listing of the swift fox and sturgeon chub was not warranted and the black-tailed prairie dog was removed from the USFWS candidate list. The USFWS identified the following threatened, endangered, or proposed species in a letter dated June 5, 2000 (status is indicated as provided in June 5, 2000 letter):

- Black-footed ferret (endangered)
- Bald eagle (threatened)

Other federally listed and candidate species, including Preble's meadow jumping mouse (threatened) and boreal toad (candidate), were not included in the June 5, 2000, letter from USFWS but were assessed in this report. In addition, the mountain plover was proposed for federal listing in 1999, but this species was subsequently withdrawn from federal listing by the USFWS in 2003. Also, the USFWS received seven petitions for listing the greater sage-grouse, including the

population in the PRB study area. However, based on a 12-month finding to list the greater sage-grouse, the USFWS subsequently has determined that the listing is not warranted (70 FR 2244).

Black-footed Ferret. The black-footed ferret (*Mustela nigripes*) is listed as a federally endangered species (USFWS 1970). The black-footed ferret historically occurred throughout Texas, Oklahoma, New Mexico, Arizona, Utah, Kansas, North and South Dakota, Montana, Wyoming, Nebraska, and Colorado. The species is closely associated with prairie dogs, depending almost entirely upon the prairie dog for its survival. The decline in populations of the ferret has been attributed to the reduction in the extensive prairie dog colonies that historically existed in the western U.S. Ferrets may occur within colonies of white-tailed or black-tailed prairie dogs. The USFWS has concluded that, at a minimum, potential habitat for the black-footed ferret must include a single white-tailed prairie dog colony of more than 200 acres, or a complex of smaller colonies within a 4.3-mile (7 km) radius totaling 200 acres (USFWS 1989). The minimum colony size for black-tailed prairie dog is 80 acres (USFWS 1989). The last known wild population of black-footed ferrets was discovered in Meeteetse, Wyoming in 1981 (USFWS 1988). Individuals from this population were captured and raised in protective captive breeding facilities in an effort to prevent extinction (Clark and Stromberg 1987). No black-footed ferrets are currently known to occur outside of reintroduced populations in Montana, South Dakota, Utah, Arizona, and Carbon County in Wyoming.

Bald Eagle. The bald eagle (*Haliaeetus leucocephalus*) was listed as endangered on February 14, 1978, in all of the conterminous U.S. with the exception of Minnesota, Wisconsin, Michigan, Oregon, and Washington, where it was classified as threatened (USFWS 1978). On July 12, 1995, the USFWS reclassified the bald eagle from endangered to threatened throughout its range in the lower 48 states (USFWS 1995). Most recently, on July 6, 1999, the bald eagle was proposed for delisting (USFWS 1999a). This proposal has not been finalized or withdrawn to-date. Bald eagles occur throughout North America from Alaska to Newfoundland, and from the southern tip of Florida to southern California. In Wyoming, this species builds large nests in the crown of large mature trees such as cottonwoods or pines. This species is an uncommon breeding resident in Wyoming, using mixed coniferous and mature cottonwood-riparian areas near large lakes or rivers as nesting habitat (Luce et al. 1999). As reported in the WGFD *Annual Completion Report 2004* (Cerovski et al. 2004), there were 80 nesting attempts in the state in 2003. This number of nesting attempts is the highest recorded since 1978. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant positive trend for populations of this species in Wyoming during the period between 1996 and 2001. The trend for the U.S., during the same period, is substantial and positive.

This species is a documented breeder and winter resident of suitable habitats within the PRB study area (Luce et al. 1999). Twelve active nests are known from within the study area, with seven nests within the Buffalo Field Office area, one within the Casper Field Office area, and four within non-BLM-administered lands. WGFD also has identified numerous winter roosts in the study area. The population of the bald eagle within the study area is expected to increase during the winter, when migrating individuals and winter residents use roost sites and suitable foraging areas. Feeding areas, diurnal perches, and night roosts are fundamental elements of bald eagle winter habitats. Although eagles can fly as far as 15 miles (24 km) to and from these elements, they primarily occur where all three elements are available in comparatively close proximity (Swisher 1964). Winter roost sites typically are associated with large cottonwood galleries or coniferous trees located along rivers, streams, or reservoirs. In Wyoming, the diet of bald eagles is more varied than in other

regions where fish are the primary food source. Wyoming grassland and shrubland habitats include a variety of suitable bald eagle prey species, including prairie dogs, lagomorphs, and big game and livestock carrion. Fish and waterfowl also are preyed upon, when available.

Preble's Meadow Jumping Mouse. The Preble's meadow jumping mouse (*Zapus hudsonius preblei*) was listed as a federally threatened species in 1998 (USFWS 1998). This species is endemic to the Colorado Piedmont east of the Front Range in east-central Colorado, along the Laramie Mountains in southeastern Wyoming, and following the North Platte River to Douglas, Wyoming (USFWS 1998).

Little is known about the habitat requirements of this species except what has been revealed in recent unpublished reports and anecdotal information from studies of small mammals in riparian areas. Apparently, this subspecies is restricted to multi-strata, streamside vegetation often in association with willows (*Salix* spp.) and in areas of thick herbaceous undergrowth. Other studies of meadow jumping mice in the eastern half of North America have reported habitat associations with grassy vegetation of adequate herbaceous ground cover (Whitaker 1963) and moist lowlands areas as opposed to mesic uplands (Quimby 1951).

In Wyoming, Preble's meadow jumping mouse have been documented in two counties: along Crow Creek at F.E. Warren Air Force Base (Laramie County), and in the Lodgepole Creek drainage within the Medicine Bow National Forest (Albany County) (USFWS 1998). Northern and eastern distribution limits for this species are not firmly established. A recent report published by the Wyoming Natural Diversity Database states that this species has been documented in the North Platte and South Platte river basins, with collection sites as far north as the town of Douglas, west to the town of Boxelder, and east to the vicinity of Slater (Beauvais 2001). This report also states that surveys for members of the same genus on the TBNG were conducted in 2000 with no captures. This species is not expected to occur within the study area.

Boreal Toad. The southern population of the boreal toad (*Bufo boreas boreas*), which occurs in the Medicine Bow Mountains, is a federal candidate species (USFWS 2002a). Region 2 of the USFS also lists this species as sensitive (USFS 2001b). This species ranges from southeastern Alaska throughout British Columbia and Alberta southward through the northwestern U.S. In Wyoming, this species occurs in two distinct populations. The northern population, not listed as a federal candidate species, ranges from mid to higher elevations of Yellowstone and Grand Teton national parks, and the Bridger-Teton, western Shoshone, and Targhee national forests. The southern population is restricted to a few isolated areas of the Medicine Bow National Forest. The southern population may be extirpated. In 2000, survey efforts located three individuals and did not observe signs of reproduction at historical breeding locations. Habitat for this species includes moist or wet areas of foothill, montane, and subalpine regions including subalpine meadows, aspen and spruce-fir forests, and all riparian habitats occurring between 8,000 and 11,900 feet amsl (USGS 2001). Adult toads are sometimes found in drier habitats when they disperse (Keinath and Bennett 2000). Current distributions are not known north of Carbon County. As a result, this species is not expected to occur within the PRB study area.

U.S. Forest Service Sensitive Wildlife Species

The Rocky Mountain Region Endangered, Threatened, Proposed, and Sensitive Species List (USFS 2001b) was used to identify sensitive plant and wildlife species that may be affected by

energy and industrial development activities within the PRB study area. The TBNG is the only public land within the PRB study area that is administered by the USFS. Therefore, only sensitive species identified as occurring within TBNG were considered in this analysis. The following USFS sensitive species were identified from the TBNG for further analysis:

- Tiger salamander
- Northern leopard frog
- Black Hills redbelly snake
- Milk snake
- Common loon
- American bittern
- White-faced ibis
- Osprey
- Ferruginous hawk
- Merlin
- Greater sandhill crane
- Long-billed curlew
- Upland sandpiper
- Mountain plover
- Black tern
- Western yellow-billed cuckoo
- Flammulated owl
- Western burrowing owl
- Lewis' woodpecker
- Olive-sided flycatcher
- Loggerhead shrike
- Purple martin
- Pygmy nuthatch
- Baird's sparrow
- Fox sparrow
- Fringed-tailed myotis
- Townsend's big-eared bat
- Black-tailed prairie dog
- Swift fox

Tiger Salamander. The tiger salamander (*Ambystoma tigrinum*) inhabits ponds, lakes, and impoundments ranging in size from several feet in diameter to several acres. Suitable habitats include clear water lakes, glacial kettle ponds, and beaver ponds below 12,000 feet amsl. The Tiger salamander is most common in permanent or semi-permanent ponds, but the species also uses ephemeral ponds that fluctuate with local moisture conditions (Hammerson 1999). This species typically is absent from waters inhabited by predatory fish. This species is expected to occur in suitable habitats throughout the PRB study area.

Northern Leopard Frog. The Northern leopard frog (*Rana pipiens*) is found throughout much of the southern half of Canada; south through the upper mid-west and central plains states; and westward into Idaho, Nevada, northern Arizona, and New Mexico (Stebbins 1985). The Northern leopard frog has experienced contractions in its range resulting from local extirpations of breeding populations, particularly in western North America (Wagner 1997). In Wyoming, this species occurs in cattail marshes and beaver ponds from the plains to montane conditions as high as 9,000 feet amsl (Luce et al. 1999). This species is expected to occur in suitable habitats throughout the PRB study area.

Black Hills Redbelly Snake. The Black Hills redbelly snake (*Storeria occipitomaculata pahasapae*) is found in the isolated refuge of the wooded Black Hills, inhabiting moist microhabitats within wooded uplands (Wyoming Bioinformation Node [WBN] 2002). It can be found near water under flat rocks, logs, and other surface objects (Luce et al. 1999). Documented occurrence in Wyoming for this species is restricted to Crook and Weston counties. Based on the species known distribution, it is not expected to occur within the PRB study area.

Milk Snake. The milk snake (*Lampropeltis triangulum)* probably has the widest distribution of any snake species in the world (Hammerson 1999). The western subspecies occurs in the western and central states from Montana southward to northern Texas, including isolated populations in Utah,

Colorado, and New Mexico (Stebbins 1985). In Wyoming, this species also is known from scattered records in the Bighorn Basin, the east slope of the Big Horn Range, and the Laramie Range in Albany, Big Horn, Washakie, Hot Springs, Platte, and Goshen counties. It also is suspected to occur in Sheridan, Campbell, Crook, Weston, Niobrara, Converse, and Natrona counties. In Wyoming, this species is found in diverse habitats from lowlands to mountains, grasslands to open forests, and wilderness to suburban settings. It often occurs in plains and foothills below 5,900 feet amsl, but it is almost never found in the short grass communities of the plains (Welp et al. 2000). This species may occur in suitable habitats within the PRB study area.

Common Loon. The common loon (*Gavia immer*) breeds throughout Canada and the northern U.S. This species typically nests on floating vegetation, muskrat houses, or shorelines of lakes with availability of suitable prey fish and invertebrate populations. In Wyoming, this species typically nests in lakes above 6,000 feet amsl and is seen using lakes at lower elevations during migration (Luce et al. 1999). The common loon has been observed throughout the majority of the state. Breeding records are restricted to the northwestern portion of the state (Luce et al. 1999). This species is not expected to nest in the PRB study area, but may be observed in suitable habitats during migration. Data presented in the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend for common loon populations in the central Rocky Mountains and the U.S. during the period between 1966 and 2001. An analysis specific to Wyoming was not available.

American Bittern. The American bittern (*Botaurus lentiginosus*) breeds from south-central British Columbia to Newfoundland. In the U.S., this species nests in all western and northern states. This species rarely wanders far from marshy, swampy areas (Yaeger 1998). This species typically feeds on fish, aquatic invertebrates, and insects. In Wyoming, this species is an uncommon summer resident occurring throughout much of the state, including the study area (Luce et al. 1999). This species may occur in suitable habitats within the study area. Data presented in the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend for American bittern populations in Wyoming and the U.S. during the period between 1966 and 2001.

White-faced Ibis. The white-faced ibis (*Plegadis chihi*) nests from central Mexico to Louisiana and Texas and through the Great Basin, with isolated colonies in Alberta, New Mexico, California, Montana, North Dakota, Iowa, and Kansas (Ryder 1998b). Preferred nesting habitat includes tall emergent vegetation such as bulrushes and cattails growing as islands surrounded by water deeper than 18 inches. Feeding habitats may include wet hay meadows and flooded agricultural croplands, as well as marshes and shallow water ponds, lakes, and reservoirs (Ryder 1998b). In Wyoming, this species is an uncommon summer resident found throughout much of the state, including the PRB study area (Luce et al. 1999). Luce et al. (1999) reported no breeding records for this species within the study area. Although this species is not expected to nest in the study area, it may occur as a seasonal migrant. Data from the BBS Trend Analysis (Sauer et al. 2001) were not presented for this species in Wyoming. Data were presented for USFWS Region 6, which includes Wyoming; they indicate a non-significant, positive trend for white-faced ibis populations in Region 6. The trend for the U.S. was highly significant and positive.

Osprey. The osprey (*Pandion haliaetus*) occurs across North America and southern Canada. This species nests in a variety of habitats throughout its range, all of which provide two primary components: a large body of water with fish large enough to catch and suitable nesting sites. Suitable nesting structures include tall dead trees, standing trees with dead, broken tops, power poles, and goose nest platforms (Barrett 1998b). In Wyoming, the osprey is a common breeding

resident nesting in suitable habitats throughout the state (Luce et al. 1999). Nesting and non-breeding observations have been documented in the PRB study area, with nesting observations restricted to the northwestern portion of the study area. This species is expected to occur in suitable habitats throughout the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant positive trend for populations of this species in Wyoming during the period between 1996 and 2001. The trend for the U.S., during the same period, is positive and significant.

Ferruginous Hawk. The Ferruginous hawk (*Buteo regalis*) is an uncommon and locally distributed occupant of grasslands, sagebrush, and desert scrub habitats in the Great Plains and Great Basin regions. On the Great Plains, breeding pairs normally are associated with native grasslands (Gilmer and Stewart 1983). In Wyoming, this species is a common breeding resident occupying basin-prairie shrublands, short grass prairie, rock outcrops, and cottonwood-riparian habitats (Luce et al. 1999). This hawk nests in trees and similar structures when available, but also would readily nests on the ground (Preston 1998a). Nest sites include cliff faces, rock outcrops, and grassy knolls (Luce et al. 1999). Studies conducted near coal mines in Campbell County, Wyoming, have reported nesting densities of one nest per 16 or 20 square miles (Seacross 2002). The ferruginous hawk is known to nest in suitable habitats throughout Wyoming and is expected to occur within the PRB study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend for populations of this species in Wyoming and the Wyoming Basin during the period between 1996 and 2001. The population trend for the U.S., during the same period, is positive and highly significant.

Merlin. The merlin (*Falco columbarius*) nests in boreal forests below treeline from coast to coast and along the western mountains south to Oregon, Idaho, and Montana. It winters in southern latitudes from the southern U.S. to South America (Udvardy 1977). In Wyoming, this species is an uncommon resident that occurs in a diversity of habitats below 8,500 feet amsl, including open grasslands and shrublands and coniferous forests (Luce et al. 1999). In the PRB study area, merlin often lay their eggs in abandoned black-billed magpie (*Pica pica*) nests. This species is a documented breeder throughout much of the state, including the study area (Luce et al. 1999). Most merlin nests in the study area are known from Rochelle Hills in southeastern Campbell County (Seacross 2002). This species may occur in suitable habitats in other areas of the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate non-significant, positive trends in population change for this species in the central Rocky Mountains and the U.S. during the period between 1966 and 2001.

Greater Sandhill Crane. The greater sandhill crane (*Grus canadensis tabida*) nests in a broad band between the 40^{TH} and 45^{TH} parallel (as far south as northern Illinois to as far north as Vancouver Island). Suitable habitat for this species includes open prairies in moist grass and sedge meadows, marshes, and shorelines (Dorn and Dorn 1990). Cranes roost at night along river channels, on alluvial islands of braided rivers, or natural basin wetlands. Along the North Platte River during the spring months, roosts are generally in shallow water (less than 20 centimeters), 11 to 50 meters from the nearest visual obstruction, and located away from paved or gravel roads, single dwellings, and bridges (Norling et al. 1992). This species often feeds and rests in fields and agricultural lands. The greater sandhill crane nests on the ground or in shallow water in large marshes or wet forest meadows. In the PRB study area, this species is an uncommon breeding resident and migrant. Two breeding pairs have been reported east of Buffalo in the Clear Creek and Piney Creek areas (Thomas 2005). Data from the BBS Trend Analysis (Sauer et al. 2001) indicate

a non-significant, positive trend in population change for this species in Wyoming during the period between 1966 and 2001. During the same period in the U.S., the trend was highly significant and positive.

Long-billed Curlew. The long-billed curlew (*Numenius americanus*) occurs from southern British Columbia to Manitoba, southeast to Wisconsin, Illinois, and Kansas, south to northern California and northern Texas (Nelson 1998a). The long-billed curlew nests on short grass prairies and feeds on insects and aquatic invertebrates in salt marshes, mud flats, and beaches (Udvardy 1977). In Wyoming, suitable habitat may include sagebrush shrublands, wet meadows, irrigated meadows, and agricultural areas (Luce et al. 1999). This species is a common summer breeding resident throughout much of central and western Wyoming. Breeding curlews have been reported from Johnson and Natrona counties and part of the PRB study area (Luce et al. 1999). Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend in population change for this species in Wyoming during the period between 1966 and 2001. During the same period across all BBS survey routes in the U.S., the trend was non-significant and negative.

Upland Sandpiper. The upland sandpiper (*Bartramia longicauda*) nests from Alaska to Maine, south to northwestern Oklahoma and the Mid-Atlantic states. The upland sandpiper nests in mid- to tall-grasslands and croplands, using the tall vegetation to hide its nest (Nelson 1998b). In Wyoming, this species nests in grasslands in the eastern portion of the state (Luce et al. 1999). This species is an uncommon breeding resident occurring in suitable habitats throughout much of eastern Wyoming, including the PRB study area (Luce et al. 1999). Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend in population change for this species in Wyoming during the period between 1966 and 2001. During the same period in the U.S., the trend was highly significant and positive.

Mountain Plover. The mountain plover (*Charadrius montanus*) was proposed for federal listing in 1999 (USFWS 1999b) but subsequently was withdrawn from federal listing in 2003 (USFWS 2003). This species occurs in high, dry, short grass prairie with vegetation typically shorter than 4 inches in height. Within this habitat, areas of blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*) are most often used, as well as areas of mixed-grass associations dominated by needle-and-thread (*Hesperostipa comata*) and blue grama (Dinsmore 1983).

Nests consist of a small scrape on flat ground in open areas. Most nests are placed in April on slopes of less than 5 degrees in areas where vegetation is less than 3 inches in height. More than half of the identified nests occurred within 12 inches of old cow manure piles and almost 20 percent were found against old manure piles in similar habitats in Colorado. Nests in similar habitats in Montana (Dinsmore 1983) and other areas (Ehrlich et al. 1988) were nearly always associated with the heavily grazed short grass vegetation of prairie dog colonies.

Mountain plovers arrive on their breeding grounds in late March with egg laying beginning in late April. Clutches are hatched by late June, and chicks fledge by late July. The fall migration begins in late August, and most birds are gone from the breeding grounds by late September.

In Wyoming, this species is a common breeding resident (Luce et al. 1999) and is expected to occur in suitable habitats within the PRB study area. Data compiled by the BLM office in Buffalo indicate that mountain plover nesting occurs sporadically throughout the study area, including northeastern Converse County, near Gillette, and Sheridan. Data from the BBS Trend Analysis

(Sauer et al. 2001) indicate a non-significant, negative trend for populations of this species in Wyoming and along all survey routes in the U.S. during the period between 1996 and 2001.

Records of mountain plover observations in the WYNDD include sightings near Buffalo and Gillette and in the TBNG. Surveys by Keinath and Ehle (2001) and Good et al. (2002) were conducted on federal lands within the study area. Keinath et al. (2001) reported 11 mountain plover observations, with one sighting in the Buffalo Resource Area south of Gillette, Wyoming. Good et al. (2002) reported six mountain plover observations, and five were located in the Buffalo Resource Area between Buffalo and Kaycee, Wyoming. These surveys were conducted on federal lands and collectively represent a small portion of the study area and the suitable habitat for plover within the study area. Non-federal lands, including private and state lands, were not included in these surveys but represent the majority of the study area (85 percent of the total acreage). Keinath et al. (2001) characterized mountain plover habitat within the study area as sparse and fragmented. Suitable mountain plover habitat is expected to occur throughout the study area.

Black Tern. In North America, the black tern (*Chlidonias niger*) breeds from southern Canada to northern California, southern Colorado, and southern New England (Nelson 1998c). This species occupies two distinct habitats during the year. During the nesting season, nests are constructed along ponds and reedy and cattail wetlands where this species feeds on insects that are picked from the air and from the surface of the water. Large wetland complexes of at least 50 acres are preferred nesting habitats for this species. In the winter, this species occurs along marine coasts, where it feeds on small fish it captures from the surface (Nelson 1998c). Some evidence of black tern breeding exists within the PRB study area (Luce et al. 1999). This species is expected to occur within the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) were not presented for this species in Wyoming. Data presented for USFWS Region 6, which includes Wyoming, and the U.S. indicate positive trends for populations of this species.

Western Yellow-billed Cuckoo. The western yellow-billed cuckoo (*Coccyzus americanus*) once ranged throughout the U.S., southern Canada, and Mexico. The range of the western subspecies has been dramatically reduced and is mostly limited to California and Arizona (Carter 1998b). In Wyoming, this species is an uncommon summer resident, occupying cottonwood riparian habitats below 7,000 feet amsl and urban areas. This species has been recorded in most areas of the state except for the montane regions (Luce et al. 1999); and may occur in suitable habitats within the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) were not presented for this species in Wyoming. Data presented for USFWS Region 6, which includes Wyoming, indicate a non-significant, negative trend for populations of this species during the period between 1966 and 2001. For the same period across all BBS routes in the U.S., the population trend was highly significant and negative.

Flammulated Owl. The flammulated owl (*Otus flammeolus*) breeds in montane forests of the western U.S. from southern British Columbia to the highlands of Mexico and Guatemala. Winter range includes southern Mexico and northern Central America (Winn 1998b). This species primarily depends on open montane forests of ponderosa or aspen for nesting, foraging, and roosting. Flammulated owls are cavity nesters and rely on old growth forests with existing woodpecker cavities for nesting. In Wyoming, this species in considered a rare accidental (Luce et al. 1999). This is supported by only limited observations in the WGFD Lat/Long study from the extreme northwestern and central portion of the state (Luce et al. 1999). Luce et al. (1999) did not report any observation records for this species within the PRB study area. Based on this data, this species is

not expected to occur within the PRB study area. An evaluation of data on population trends for this species was not included in the BBS Trend Analysis (Sauer et al. 2001). This species was most likely excluded from this report because BBS surveys are conducted during daylight, which most likely would miss species that are strictly nocturnal, such as the flammulated owl.

Western Burrowing Owl. The western burrowing owl (*Athene cunicularia*) occurs from south-central British Columbia eastward to southern Saskatchewan and south through most of the western U.S. Burrowing owls primarily nest in rodent burrows, particularly prairie dog burrows, in grasslands, shrublands, deserts, and grassy urban settings (Jones 1998a). In Wyoming, this species uses grasslands, sagebrush and other shrublands, and agricultural areas. This species is a confirmed breeder throughout much of the state (Luce et al. 1999) and is known to occur as a summer resident in suitable habitats within the study area. Populations of this species can vary considerably within the PRB study area, influenced by fluctuations in the availability of prey. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate non-significant, negative trends in population change for this species in Wyoming and the U.S. during the period between 1966 and 2001.

Lewis' Woodpecker. Lewis' woodpecker (*Melanerpes lewis*) occurs from southern British Columbia and Alberta south to northern Arizona and south-central California. Suitable habitat for this species includes pine-oak woodlands, oak or cottonwood groves in grasslands, and ponderosa pine forests (Udvardy 1977). In Wyoming, this species principally occurs in open ponderosa and lodgepole pine forests and savannah and recently burned forests with abundant snags or stumps, mainly below 9,000 feet amsl. It also uses aspen, mixed pine-juniper, and cottonwood riparian habitats. Mated pairs may return to the same nest site in successive years (Welp et al. 2000). The species is known to occur throughout most of Wyoming, except for higher elevation mountain regions (Luce et al. 1999). This species may occur in suitable habitats within the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate non-significant, positive trends in population change for this species in Region 6 of the USFWS, which includes Wyoming, and the U.S. during the period between 1966 and 2001.

Olive-sided Flycatcher. The olive-sided flycatcher (*Contopus cooperi*) breeds in boreal forests from Alaska to Newfoundland and in the mountains of the western U.S. (Jones 1998b). Most nesting takes place in coniferous forests from 8,000 feet amsl to timberline (Luce et al. 1999). In Wyoming, this species is a common summer resident with documented breeding limited to montane habitats of the south, central, and western portion of the state. Suitable habitats for this species are not expected to occur within the PRB study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend for populations of this species in Wyoming during the period between 1966 and 2001. For the same period across all BBS routes in the U.S., the population trend was highly significant and negative.

Loggerhead Shrike. The loggerhead shrike (*Lanius ludovicianus*) occurs from North America south of the coniferous forest region into Mexico (Udvardy 1977). The loggerhead shrike typically is associated with open vegetation types, including agricultural areas, sagebrush shrublands, desert scrub, piñon-juniper woodlands, and montane meadows (Johnsgard 1986). In Wyoming, this species is a common summer resident, using pine-juniper, woodlands, short- and mixed-grass prairies, and shrublands. This species is known to breed throughout the state (Luce et al. 1999) and is known to occur in suitable habitats within the PRB study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend for populations of this species in

Wyoming during the period between 1966 and 2001. For the same period across all BBS routes in the U.S., the population trend was highly significant and negative.

Purple Martin. The purple martin (*Progne subis*) breeds locally throughout the eastern U.S. from the Atlantic to the Great Plains, across the Southwest, and up the Pacific coast from south-central California to British Columbia (Levad 1998). Throughout their range, purple martin nest in a variety of habitats, including cavities in cacti, cliffs, trees, and manmade nest houses, typically near a stream, spring, or pond (Levad 1998). In Wyoming, most nesting occurs in similar habitats below 7,000 feet amsl. This species has been recorded in the Bighorn, Medicine Bow, and Wind River ranges of Wyoming (Luce et al. 1999). No observations have been reported for the PRB study area (Luce et al. 1999). This species is not expected to occur within the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate non-significant, positive trends in population change for this species in Region 6 of the USFWS, which includes Wyoming, and the U.S. during the period between 1966 and 2001.

Pygmy Nuthatch. The pygmy nuthatch (*Sitta pygmaea*) is widespread from southern British Columbia eastward through the Black Hills, and south to Baja California and mainland Mexico (Udvardy 1977). In Wyoming, it occurs in scattered locales during the winter. During the breeding season, it is associated with mountain habitats in coniferous forests at the periphery of the state. This species has been observed breeding in the Bighorn and Medicine Bow national forests and in most other coniferous habitats within the state. Ponderosa pine woodlands in the Black Hills and in the Douglas/Guernsey regions have the best potential to support large groups of breeding birds (Welp et al. 2000). This species may occur in suitable habitats within the PRB study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate non-significant, positive trends in population change for this species from the Central Rocky Mountains, which includes Wyoming, and the U.S. during the period between 1966 and 2001.

Baird's Sparrow. The Baird's sparrow (*Ammodramus bairdii*) ranges from Alberta, Saskatchewan, and Manitoba and Montana to South Dakota (Udvardy 1977). In Wyoming, this species is an uncommon summer resident using short grass prairie habitats (Luce et al. 1999). This species may occur in suitable habitats within the PRB study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate non-significant, negative trends in population change for this species in Region 6 of the USFWS, which includes Wyoming, and the U.S. during the period between 1966 and 2001.

Fox Sparrow. The fox sparrow (*Passerella iliaca*) is a North American migrant, breeding across Canada and the western U.S. and wintering south of Colorado along the Pacific coast and in the southern U.S. and northern Mexico (Potter and Roth 1998). In Wyoming, this species occupies a variety of breeding habitats including riparian shrublands with adjacent coniferous forest or woodland chaparral and burned or logged forests (Luce et al. 1999). This species occurs widely in Wyoming with most confirmed breeding records west of the Rocky Mountains. This species has been observed and unconfirmed breeding has been documented within the PRB study area (Luce et al. 1999). Data from the BBS Trend Analysis (Sauer et al. 2001) indicate non-significant, positive trends in population change for this species from Wyoming and the U.S. during the period between 1966 and 2001.

Fringed-tailed Myotis. The fringed-tailed myotis (*Myotis thysanodes pahasapensis*) ranges from British Columbia through western North America to southern Mexico. In Wyoming, this species is found along the eastern edge of the state from the Black Hills to Laramie in Weston, Platte, Albany,

Sublette, and Laramie counties (Welp et al. 2000). This species is associated with a variety of vegetation community types, including montane meadows, sagebrush shrublands, desert scrub, mixed grass prairies, and woodlands, although it appears to prefer coniferous forests (Fitzgerald et al. 1994). Caves, mines, and buildings are used as day and night roosts for colonies of up to several hundred individuals. Although no breeding has been reported within the PRB study area, this species has been observed within the PRB study area (Luce et al. 1999) where it may occur in suitable habitats.

Townsend's Big-eared Bat. Townsend's big-eared bat (*Corynorhinus townsendii* [*Plecotus townsendii*]) is most common throughout the western half of North America and occurs south into central Mexico. Although Wyoming forms part of the core of this main range, it is distributed sparsely throughout the state (Clark and Stromberg 1987). It has been recorded in Converse, Goshen, Platte, Crook, Fremont, Big Horn, Hot Springs, Sweetwater, Washakie, Park, and Johnson counties. Suitable habitats in Wyoming include deciduous forests, dry coniferous forests, sagebrush and other shrublands, short grass and mixed grass prairies, and juniper woodlands. This species uses caves, buildings, and rock outcrops for day and night roosts and hibernation sites (Luce et al. 1999). Although no breeding has been reported within the study area, this species has been observed within the study area (Luce et al. 1999) where it may occur in suitable habitats.

Black-tailed Prairie Dog. The black-tailed prairie dog (*Cynomys ludovicianus*) was added to the list of candidate species for federal listing on February 4, 2000 (USFWS 2000). This species was subsequently removed from the USFWS candidate species list in 2004 (69 Federal Register [FR] 51217).

The black-tailed prairie dog is a highly social, diurnally active, burrowing mammal. Aggregations of individual burrows, known as colonies, form the basic unit of prairie dog populations. Found throughout the Great Plains in short-grass and mixed-grass prairie areas (Fitzgerald et al. 1994), the black-tailed prairie dog has declined in population and extent of colonies in recent years because of habitat destruction or disturbance and pest control. In Wyoming, this species primarily is found in isolated populations in the eastern half of the state (Clark and Stromberg 1987). Many other wildlife species, such as the black-footed ferret, swift fox, mountain plover, ferruginous hawk, and burrowing owl, depend on the black-tailed prairie dog for some portion of their life cycle (USFWS 2000).

This species is considered a common resident, inhabiting short grass and mid-grass habitats in eastern Wyoming (Luce et al. 1999). Active and inactive prairie dog colonies are known to occur within the PRB study area; however, specific data on population and occurrence patterns are not available.

Swift Fox. In January 2001, the USFWS did not support listing this species as threatened under the ESA (USFWS 2001a) based on new biological information. The swift fox (*Vulpes velox*) is found in short- and mixed-grass prairie habitats. It appears to prefer flat to gently rolling terrain. The swift fox preys on small rodents, rabbits, and birds. Pups emerge from the den in June. Dens generally are located along slopes or ridges that offer good views of the surrounding area (Fitzgerald et al. 1994). Where they are abundant, they occur at a density of one pair per 1,200 to 2,000 acres. Individuals may roam over 2,000 to 2,500 acres during a night of hunting (Clark and Stromberg 1987). In Wyoming, this species is considered a common resident in grasslands in the eastern plains,

agricultural areas, irrigated native meadows, and the banks of roads and railroads (Luce et al. 1999). This species may occur in suitable habitats within the PRB study area.

Wyoming BLM Sensitive Wildlife Species

In a memorandum dated April 9, 2001, the Wyoming BLM issued its Sensitive Species Policy and List (Pierson 2001). An update to this was published September 20, 2002 (BLM 2002b). Sensitive wildlife species that may be affected by energy and industrial development activities within the PRB study area were identified from this list and evaluated in this assessment. Species within the Buffalo and Casper field office areas were selected from the sensitive species list for further evaluation. The following BLM sensitive species were identified for analysis:

- Long-eared myotis
- Spotted bat
- Townsend's big-eared bat
- White-tailed prairie dog
- Swift fox
- White-faced ibis
- Trumpeter swan
- Western yellow-billed cuckoo
- Western burrowing owl
- Northern goshawk
- Ferruginous hawk
- Peregrine falcon
- Greater sage-grouse
- Long-billed curlew
- Sage thrasher
- Loggerhead shrike
- Brewer's sparrow
- Sage sparrow
- Baird's sparrow
- Yellowstone cutthroat trout
- Northern leopard frog
- Columbia spotted frog

The northern leopard frog, white-faced ibis, ferruginous hawk, long-billed curlew, western yellow-billed cuckoo, western burrowing owl, loggerhead shrike, Baird's sparrow, mountain plover, Townsend's big-eared bat, black-tailed prairie dog, and swift fox are also USFS Region 2 sensitive species and have been addressed previously in the section on USFS Sensitive Species.

Columbia Spotted Frog. The Columbia spotted frog (*Rana luteiventris* [*Rana pretiosa*]) occurs throughout much of British Columbia and in Washington, Oregon, Idaho, Montana, Nevada, Utah, and Wyoming (Stebbins 1985). Wyoming is on the eastern edge of the range, where it is known from Park, Teton, Lincoln, Fremont, Sheridan, and Sublette counties. The primary population is in the northwestern part of the state, where it is contiguous with populations in Idaho and Montana (Welp et al. 2000). A glacial disjunct population occurs in the Big Horn Mountains about 100 miles to the east of the primary, contiguous population. It is confined to the headwaters of the South Tongue River drainage and its tributaries in Sheridan County (Garber 1994). In Wyoming, suitable habitats can be found in foothills and montane zones usually near permanent water such as ponds, sloughs, small streams, and beaver ponds. This species may avoid areas with warm stagnant water and dense cattails. It breeds in old oxbow ponds in which fish are absent, with emergent sedges in wet meadows at the edge of lodgepole pine forests (Garber 1994). The disjunct population of this species associated with the Tongue River is within the study area. No other populations are known to exist in the study area.

Trumpeter Swan. The trumpeter swan (*Cygnus buccinator*) breeds in southern Alaska, northern British Columbia, western Alberta, Oregon, Idaho, Montana, and Wyoming. As a result of habitat destruction and over-hunting, this species was close to extinction, but careful management and

reintroduction practices have helped return the population to several thousand individuals (Udvardy 1977). Suitable habitats for this species include lakes and ponds with developed aquatic vegetation for feeding and nesting materials (Terres 1980). CBNG reservoirs occasionally are used during migration; however, in many cases, appropriate vegetative cover and foraging areas have not developed around these reservoirs. This species has been observed throughout the state, including the PRB study area (Luce et al. 1999). No confirmed nesting has been reported for this species in the study area (Luce et al. 1999). This species may nest in suitable habitats within the study area; however, most occurrences are expected to be migrating individuals. Population trend data for this species were not included in the BBS Trend Analysis (Sauer et al. 2001).

Northern Goshawk. The northern goshawk (*Accipiter gentiles*) occurs from Alaska through the Rocky Mountains to New Mexico and in the mountains and forests of Washington, Oregon, and interior California (Udvardy 1977). Goshawks typically prey on squirrels, ducks, and other birds. The northern goshawk nests in a variety of habitats including conifer and aspen forests, and occasionally cottonwood trees (Barrett 1998d). This species is a documented breeding resident of Wyoming, including the PRB study area (Luce et al. 1999). This species is expected to occur in suitable habitats within the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend for populations of this species in Wyoming during the period between 1966 and 2001. For the same period across all BBS routes in the U.S., the population trend was non-significant and negative.

Peregrine Falcon. The peregrine falcon (*Falco peregrinus anatum*) was removed from the federal list of endangered species in 1999 (USFWS 1999c). This species occurs across North America and uses a variety of habitats. The peregrine falcon typically is associated with open country near rivers, marshes, and coasts. Cliffs are preferred nesting substrate; however, tall man-made structures also may be used. Peregrines typically prey on birds such as waterfowl, shorebirds, grouse, and pigeons. In Wyoming, this species is a rare resident with most breeding records from the western portion of the state (Luce et al. 1999). This species is not expected to nest in the PRB study area, but may occur as a seasonal migrant. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate significant, positive trends in population change for this species in Region 6 of USFWS, which includes Wyoming, and the U.S. during the period between 1966 and 2001.

Greater Sage-grouse. The greater sage-grouse and was petitioned for federal listing consideration under the ESA. However, based on a 12-month finding to list the greater sage-grouse, the USFWS has subsequently determined that the listing is not warranted (70 FR 2244).

The greater sage-grouse is highly dependent on sagebrush communities (Schroeder et al. 1999). It occurs on the plains and foothills of the arid west and can be found in short-grass and mixed-grass prairies, sagebrush shrublands, other shrublands, wet meadows, and agricultural areas, always associated with substantial stands of sagebrush. In Wyoming, this species occurs as a breeding resident in suitable habitats below 8,300 feet amsl (Luce et al. 1999). Unlike in many other western states, the current range of the greater sage-grouse in the study area has not substantially contracted from its historical extent (WGFD 2002a). Although the range of this species is relatively unchanged, the population numbers have been trending downward in recent years. This decrease has been associated with the disturbance and destruction of suitable grouse habitats (Oedekoven 2001). **Figure 2.4-6** shows the distribution of potentially suitable greater sage-grouse habitats in the PRB study area. **Table 2.4-13** summarizes the extent of potentially suitable habitats in the study area.

Table 2.4-13
Greater Sage-grouse Potential Habitats and Lek Sites

Subwatershed	Potentially Suitable Habitats			Number of Lek Sites
	Primary Habitats (percent)	Secondary Habitats (percent)	Non-habitat (percent)	
Little Bighorn River	8.1	24.4	67.5	0
Upper Tongue River	45.5	28.5	26.0	23
Middle Fork Powder River	21.6	23.5	54.9	20
North Fork Powder River	2.0	12.6	85.4	0
Upper Powder River	73.4	25.8	0.9	78
South Fork Powder River	54.4	19.7	25.9	12
Salt Creek	76.4	16.5	7.1	9
Crazy Woman Creek	56.4	16.2	27.3	34
Clear Creek	58.2	27.3	14.5	19
Middle Powder River	53.0	39.4	7.6	3
Little Powder River	63.1	32.1	4.8	46
Little Missouri River	15.7	79.1	5.2	0
Antelope Creek	30.9	56.5	12.6	15
Dry Fork Cheyenne River	29.1	70.8	0.1	33
Upper Cheyenne River	79.1	9.4	11.6	10
Lightning Creek	62.3	34.0	3.8	7
Upper Belle Fourche River	68.7	29.2	2.1	57
Middle North Platte River	45.9	53.1	1.1	19
Average	**55.9**	**31.7**	**12.4**	**---**

Source: BLM 2003a; Christiansen 2005.

Males of this species have an extravagant mating display that is performed on historical strutting areas termed “leks.” Male greater sage-grouse, particularly juveniles, are known to attend several different leks within a single breeding season (Schroeder et al. 1999). The components of lek habitat are discussed below. WGFD’s 2003 sage-grouse report (Oedekoven 2003) reported 314 lek sites in the WGFD’s Sheridan Region, which approximates the study area. Based on GIS information (BLM 2003a; Christiansen 2005), as of the end of 2003, there were 385 lek sites in the study area. Lek complexes occur in many locations and are defined as one or more leks within 0.5 to 2.0 miles of each other. **Figure 2.4-6** shows the distribution of known lek sites in the study area. **Table 2.4-13** summarizes the distribution of known lek sites.

WGFD relied on lek data as the basis for analyzing trends in the population of greater greater sage-grouse. These lek data represent minimum population estimates, because not all of the leks in the study area have been identified. Approximately one-half to one-third of the known leks are checked every year; for the last several years, searches for new leks also have been conducted, resulting in the discovery of 65 new leks over the past 4 years (Oedekoven 2001, 2002). The number of active leks and lek complexes has varied over the past 10 years, as has the estimated population. The population in the Sheridan Region appears to follow a 10-year cycle. Starting in 1992 with an estimate of 6,256 grouse, the population declined until reaching a low of 2,091 grouse in 1994, stayed at this level until 1997 and then increased to a high of 10,804 in 2000. Each successive peak in 2000, 2001, and 2002 has been lower than the subsequent peak, presumably due to sustained drought conditions in the region (Oedekoven 2003).

Seasonal range use and movements of greater sage-grouse vary considerably between populations, with movements in some populations exceeding 45 miles (Connelly et al. 1988). Depending on the migratory nature of the population, these ranges may overlap or may be geographically distinct (Connelly et al. 2000). Within the overall range of a population, a series of habitats are used during the year. Their spatial arrangement, relative availability, and the condition of the vegetation all affect the potential of these habitats to support greater sage-grouse. Six seasonal habitats have been defined for greater sage-grouse in Wyoming (WGFD 2002a). Each of these habitats has components that are important for sage-grouse reproduction and survival. These habitats include:

Winter Habitat. Greater sage-grouse feed almost exclusively on sagebrush during the winter period. Winter habitats generally contain a canopy cover of 15 percent or greater of taller sagebrush and are located in areas where snow depths do not restrict access to sagebrush, such as south-facing slopes and windswept areas (Connelly et al. 2000; WGFD 2002a).

Breeding Habitat (Leks) — Early Spring. Leks are used from March to May and generally are located in open areas such as broad ridges, grassy areas, and disturbed sites (WGFD 2002a). Greater sage-grouse select sites with less sagebrush and other shrub cover than the surrounding landscape, although these sites are often surrounded by sagebrush that is used as cover and for foraging by females that attend the lek and by non-displaying males (Schroeder et al. l999). Habitats that surround the lek site also are important because they provide the forage needed by hens to produce eggs and are often used for nesting (Braun et al. 1977), although migratory populations are much less centered around lek sites than are non-migratory populations (Connelly et al. 2000).

Nesting Habitat — Late Spring. Nests generally are placed under sagebrush, but other large shrubs can be used (WGFD 2002a). Greater sage-grouse select nest sites with higher than average canopy cover of sagebrush and herbaceous plant density, which leads to increased nest success (Connelly et al. 2000).

Early Brood Rearing Habitat — June to Mid-July. This habitat is used during the first month of the brood's life (WGFD 2002a). The brood is moved from the nest site immediately after it hatches and may move up to 5 miles in the first 10 days. This habitat generally has a higher herbaceous cover because brood survival is closely related to the availability of forbs and insects, which make the most important part of chick diets (Schroeder et al. 1999).

Late Brood Rearing Habitat — Mid-July through Mid-September. During this period, many upland forbs have dried up and greater sage-grouse typically move to wetter locations, such as higher elevations or riparian areas (WGFD 2002a). Broods tend to move to sites with higher than average forb cover and would focus on relatively small areas if the necessary forage is available (Connelly et al. 2000).

Fall Habitat — Mid-September to First Major Snow. Movement to, and use of, fall habitat is variable, depending on the weather and condition of forage. In Wyoming, this habitat typically is used from mid-September until the first major snow (WGFD 2002a). During this period, grouse shift from feeding on forbs for the most part, to relying heavily on sagebrush as the forbs are killed or become dormant caused by frost (Connelly et al. 2000).

None of these habitats have been defined for the study area. Little is known of the seasonal movements of greater greater sage-grouse in the study area. However, based on the general distribution of sagebrush, it is likely that some sage grouse are present in much of the PRB study area throughout the year. Populations are either resident or exhibit semi-migratory behavior, moving locally to different food resources or to escape deep snow or moving between distinct breeding and wintering areas (Naugle 2004a).

Existing Impacts. As a result of past and on-going human activities in the study area, substantial areas of greater sage-grouse habitats have been altered from their natural conditions (**Table 2.4-14**). Human disturbances include, but are not limited to, agriculture, mining, roads, urban areas, oil and gas well pads, compressor sites, and other ancillary facilities. The amount of habitat loss, including sagebrush, as a result of existing activities is shown by surface ownership and subwatershed in **Tables 2.3-3** and **2.3-4**, respectively. Specific data on roads are not available in sufficient detail to allow comparison with these data and are not presented in **Table 2.4-14**. Road density is discussed in Section 2.4.3.2, Habitat Fragmentation. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate statistically significant, positive trends in population change for this species in Wyoming and the U.S., during the period between 1966 and 2001. BBS data may be misleading because 2000 appears to have been the peak year of the 10-year greater sage-grouse population cycle. Subsequent years are likely to have lower population numbers. In addition, long-term data indicate that each successive population cycle peak is lower than the previous one, suggesting a long-term population decline (Oedekoven 2001).

Table 2.4-14
Existing Impacts to Greater Sage-grouse Lek Protective Buffers by Subwatershed

Subwatershed	Total Number of Leks	Number of Leks With Development-related Disturbance Within the 2.0-mile Buffer
Little Bighorn River	0	0
Upper Tongue River	23	14
Middle Fork Powder River	20	1
North Fork Powder River	0	0
Upper Powder River	78	69
South Fork Powder River	12	0
Salt Creek	9	7
Crazy Woman Creek	34	5
Clear Creek	19	13
Middle Powder River	3	3
Little Powder River	46	41
Little Missouri River	0	0
Antelope Creek	15	14
Dry Fork Cheyenne River	33	31
Upper Cheyenne River	10	10
Lightning Creek	7	6
Upper Belle Fourche River	57	57
Middle North Platte River	19	15
Total	**385**	**286**

Source: ENSR 2005b.

The outbreak of West Nile virus in greater sage-grouse populations in Wyoming and Montana currently is being studied by the University of Montana, University of Alberta, and an environmental consulting firm near Gillette, Wyoming (USGS 2003). In the Wyoming and Montana PRB, the late summer survival of sage-grouse was lower at a site with confirmed West Nile virus mortalities than at two sites without (Naugle 2004b). Based on the observed pattern of sage grouse mortalities, CBNG development has been identified as one of many possible explanations for the outbreak of the virus in the greater sage-grouse. However, at this time, no link to CBNG development has been identified (USGS 2003).

Sage Thrasher. The sage thrasher (*Oreoscoptes montanus*) occurs from south-central British Columbia to southern Nevada, Utah, through Texas and Oklahoma, and in the San Joaquin Valley of California (Udvardy 1977). In Wyoming, this species is a common summer resident breeding in sagebrush shrublands throughout the state (Luce et al. 1999). This species may occur in suitable habitats within the PRB study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend for populations of this species in Wyoming during the period between 1966 and 2001. For the same period across all BBS routes in the U.S., the population trend was non-significant and negative.

Brewer's Sparrow. The Brewer's sparrow (*Spizella breweri*) ranges from British Columbia east to Saskatchewan, south to New Mexico, Arizona, and southern California (Udvardy 1977). In Wyoming, this species is a common summer resident occupying sagebrush shrubland and other shrubland habitats throughout the state (Luce et al. 1999). Brewer's sparrow typically feed on insects and seeds. This species may occur in suitable habitats within the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, negative trend for populations of this species in Wyoming during the period between 1966 and 2001. For the same period across all BBS routes in the U.S., the population trend was highly statistically significant and negative.

Sage Sparrow. The sage sparrow (*Amphispiza belli*) occurs from Washington south to Baja California and throughout the Great Basin (Udvardy 1977). The sage sparrow is a common summer resident in the Wyoming grasslands and shrublands typically feeding on insects and seeds (Luce et al. 1999). This species may occur in suitable habitats within the study area. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate no significant trend changes for populations of this species in Wyoming during the period between 1966 and 2001. For the same period across all BBS routes in the Untied States, the population trend was non-significant and positive.

Long-eared Myotis. The long-eared myotis (*Myotis evotis*) occurs throughout the western portion of North America, south to Baja California. Wyoming is close to the eastern periphery of its range. Clark and Stromberg (1987) reported that this species is distributed throughout Wyoming, with records in Park, Big Horn, Teton, Platte, Fremont, Sublette, Natrona, Sweetwater, Carbon, and Laramie counties. In sagebrush steppe habitat, such as Sweetwater County, they probably are limited to small stands of conifers. Preferred habitats include coniferous forests, including ponderosa pine and spruce-fir, forests, sagebrush shrublands, and grasslands (Luce et al. 1999). This species roosts in caves, buildings, and mine tunnels (Clark and Stromberg 1987). This species may occur in suitable habitats within the PRB study area.

Spotted Bat. The spotted bat (*Euderma maculatum*) occurs in western North America from Mexico to the southern border of British Columbia. Wyoming is on the northeast periphery of its range (Welp et al. 2000). In Wyoming, a single documented occurrence of this species exists from near Byron (Clark and Stromberg 1987). Suitable habitat in Wyoming includes juniper and sagebrush shrublands, short-, and mixed-grass prairies (Luce et al. 1999). Roosting sites in rock crevices and cliff complexes also are known to be important (Welp et al. 2000). This species is often described using cliffs over perennial water (Clark and Stromberg 1987). In Wyoming, occurrence records are restricted to the Big Horn Mountains and the southwestern portion of the state (Luce et al. 1999). This species is not expected to occur within the study area.

White-tailed Prairie Dog. The white-tailed prairie dog (*Cynomys leucurus*) occurs in parts of Colorado, Utah, Wyoming, and Montana. In Wyoming, it is a common resident, occupying sagebrush shrublands, and short- and mixed-grass prairie throughout much the state, excluding the northeastern portion (Luce et al. 1999). This species is not expected to occur in the PRB study area (USFWS 2002a).

Wyoming Game and Fish Department Sensitive Species

The Species of Special Concern (SSC) list for WGFD sensitive species was reviewed, and species with the potential to occur in the PRB study area were identified. Sources including Clark and Stromberg (1987), Luce et al. (1999), and WBN were used to evaluate the presence or absence of a species in the study area. The following WGFD sensitive species may occur in the study area and therefore are included in this analysis.

- Common loon
- American white pelican
- American bittern
- Black-crowned night heron
- Snowy egret
- White-faced ibis
- Trumpeter swan
- Black tern
- Bald eagle
- Ferruginous hawk
- Merlin
- Peregrine falcon
- Long-billed curlew
- Western yellow-billed cuckoo
- Lewis' woodpecker
- Long-eared myotis
- Long-legged myotis
- Townsend's big-eared bat
- Little brown myotis
- Big brown bat
- Western small-footed myotis
- Black-tailed prairie dog
- Black-footed ferret
- Swift fox

The black-footed ferret and bald eagle also are federally listed species. Each of these species has been addressed previously in the Federally Listed Species sub-section. The common loon, white-faced ibis, ferruginous hawk, long-billed curlew, American bittern, black tern, merlin, Lewis' woodpecker, western yellow-billed cuckoo, Townsend's big-eared bat, and swift fox also are USFS Region 2 sensitive species and previously have been addressed in the USFS Sensitive Species subsection. The trumpeter swan, peregrine falcon, and long-eared myotis also are Wyoming BLM sensitive species and have been addressed previously in the Wyoming BLM Sensitive Species subsection.

American White Pelican. The American white pelican (*Pelecanus erythrorhynchos*) breeds in widely scattered colonies in western North America from northern Alberta to western Ontario and northeastern California to Utah and Colorado. In winter, this species migrates to coastal Texas and Mexico (Potter 1998a). Although breeding has been documented in the state, no recent observations have been recorded (Luce et al. 1999). This species may occur in the PRB study area as a nonbreeding migrant. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate statistically significant, positive trends in population change for this species in both Wyoming and the U.S., during the period between 1966 and 2001.

Black-crowned Night Heron. The black-crowned night heron (*Nycticorax nycticorax*) breeds throughout most of the U.S. (Potter 1998b). These herons typically construct flimsy twig nests in the lower branches of cottonwood trees, willows, and shrubs, and occasionally build their nests in emergent vegetation over water. Black-crowned night herons forage for mollusks, insects, fish, amphibians, reptiles, birds, and small mammals in shallow water bodies and along the edge of aquatic habitats. Documented observations of this species have been recorded throughout much of the state, with historical breeding records from the southern half of the state. This species is not expected to nest in the PRB study area, but may occur as a seasonal migrant. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, positive trend in population change for this species in Region 6 of the USFWS, which includes Wyoming, during the period between 1966 and 2001. The population trend for this species across the U.S. for the same period was highly significant and positive.

Snowy Egret. The snowy egret (*Egretta thula*) nests throughout the Great Basin, Texas, Louisiana, Florida, and in the San Luis Valley in Colorado (Ryder 1998a). This species nests in colonies, typically in willow or cottonwood trees and in tall cattail or bulrush wetlands. Snowy egret feeding habitats include marshes, wet meadows, streams, rivers, and shorelines of shallow ponds and reservoirs (Ryder 1998a). Evidence of breeding has been recorded in southern and southwestern Wyoming. This species is not expected to nest in the PRB study area, but may occur as a seasonal migrant. Data from the BBS Trend Analysis (Sauer et al. 2001) indicate a non-significant, negative trend in population change for this species in Region 6 of the USFWS, which includes Wyoming, during the period between 1966 and 2001. The population trend for this species across the U.S. for the same period was highly significant and positive.

Long-legged Myotis. The long-legged myotis (*Myotis volans*) occurs throughout the western half of North America. They are the most abundant *Myotis* in the west and are common throughout Wyoming (Clark and Stromberg 1987). Habitats include oak, ponderosa pine, and mixed deciduous-coniferous forests, shrublands, and riparian areas (Luce et al. 1999). The long-legged myotis may occur in suitable habitats within the PRB study area.

Little Brown Myotis. The little brown myotis (*Myotis lucifugus*) occurs throughout North America except in the extreme portions of the southern states (Burt and Grossenheider 1980). This bat species occupies a variety of habitats that are near water, including coniferous and deciduous forests, sagebrush shrublands, grasslands, and riparian areas (Luce et al. 1999). This species forages over water. The little brown myotis may occur in suitable habitats within the PRB study area.

Big Brown Bat. The big brown bat (*Eptesicus fuscus*) occurs throughout North America with the exception of parts of Florida (Burt and Grossenheider 1980). This species forages over open

meadows, tree-lined streets, corrals, and around farms and ranches (Clark and Stromberg 1987). Historical records and recent observations have been documented within the PRB study area (Luce et al. 1999). This species may occur in suitable habitats within the study area.

Western Small-footed Myotis. The western small-footed myotis (*Myotis ciliolabrum*) occurs throughout the western half of the U.S. and parts of Mexico (Clark and Stromberg 1987). In Wyoming, this species may occupy a variety of habitats, including pine-juniper, sagebrush shrublands, grasslands, foothills, cliffs, and outcrops (Luce et al. 1999). This species has been observed throughout Wyoming, including the study area (Luce et al. 1999). This species may occur in suitable habitats within the PRB study area.

Special Status Fish Species

Eleven fish species that potentially occur in the project area subwatersheds have special status designations (**Table 2.4-15**). No federally listed, proposed for listing, or candidate fish species occur in the project study area. However, 11 species have special status by the BLM, USFS, or WGFD. Yellowstone cutthroat trout is considered a sensitive species by the BLM, while the flathead chub and plains topminnow are considered USFS sensitive. All 11 species have one of the three highest priority designations (SSC1, SSC2, and SSC3) by the WGFD. These designations are defined as follows:

Table 2.4-15
Sensitive Aquatic Species in the PRB Study Area

Common Name	Scientific Name	Status
Flathead chub	Platygobio gracilis	FSS, SSC3
Plains topminnow	*Fundulus sciadicus*	FSS, SSC3
Yellowstone cutthroat trout	*Oncorhynchus clarki bouveri*	BLM, SSC2
Sauger	*Stizostedion candense*	SSC2
Black bullhead	*Ameirus melas*	SSC3
Goldeye	*Wiodon alosodies*	SSC2
Lake chub	*Couesius plumbeus*	SSC3
Mountain sucker	*Catostomous platyrhynchus*	SSC3
Silvery minnow	*Hybognathes nuchalis*	SSC1
Plains minnow	*Hybognathus placitis*	SSC3
Sturgeon chub	*Macrhybopsis gelida*	SSC1

[1]FFS = Forest Service Sensitive; BLM = BLM Sensitive Species; SSC1, SSC2, and SSC3 = WGFD sensitive species categories (described in text).

- SSC1: Includes species with ongoing significant loss of habitat and with populations that are greatly restricted or declining (extirpation appears possible).

- SSC2: Species in which: 1) habitat is restricted or vulnerable (but no recent or significant loss has occurred) and populations are greatly restricted or declining; or 2) species with on-going significant loss of habitat and populations that are declining or restricted in numbers and distribution (but extirpation is not imminent).

- SSC3: Species in which: 1) habitat is not restricted, but populations are greatly restricted or declining (extirpation appears possible); or 2) habitat is restricted or vulnerable (but no recent or significant loss has occurred) and populations are declining or restricted in numbers or distribution (but extirpation is not imminent); or 3) significant habitat loss is on-going but the species is widely distributed and population trends are thought to be stable.

The following information summarizes the potential occurrence, habitat use, and spawning for the sensitive fish species in the study area. Information for sauger and black bullhead is provided in **Table 2.4-12**.

Flathead Chub. In Wyoming, the flathead chub is common in the major river systems east of the Continental Divide, with the exception of the Madison, Yellowstone, Niobrara, and South Platte River systems. It is known to occur in five basins (Powder River, Little Powder River, Tongue River, Cheyenne, Little Bighorn, and Little Missouri) and 12 subwatersheds within the project study area (Appendix B, **Table B1**). Surveys conducted in 2002 collected this species in the mainstem portion of the Powder River and several tributary draws (Van Heuten and Berger) (WGFD 2003). The preferred habitat for this species is relatively large rivers and streams in areas with swift currents and sand or gravel substrates (Woodling 1985; Baxter and Simon 1970). This species is omnivorous, primarily feeding on aquatic and terrestrial insects and vegetation. The spawning period is suspected to occur in the late summer (Baxter and Simon 1970). Primary threats to this species include nonpoint source pollution and mainstem impoundments that greatly alter the natural water flow regimes.

Plains Topminnow. Baxter and Simon (1970) reported this fish occurring in North and South Platte drainages, Niobrara River, and headwaters of the Cheyenne River System. This species is known to occur in Sage Creek, a small tributary located in the upper Cheyenne River subwatershed. In Wyoming, the plains topminnow characteristic habitat is clear, sand or gravel-bottomed streams with considerable vegetation (Baxter and Simon 1970). It often is collected in streams inhabited by plains killifish. Spawning occurs in late spring or early summer in habitat with aquatic macrophytes (Woodling 1985).

Yellowstone Cutthroat Trout. In February 2001, USFWS concluded that a petition to list the Yellowstone cutthroat trout as a threatened species under the Endangered Species Act did not provide substantial biological information to indicate that listing may be warranted (USFWS 2001a). This species is native to the Yellowstone River drainage downstream to the Tongue River, including the Big Horn/Wind and Clarks Fork River drainages (Welp et al. 2000). This species is also found west of the Continental Divide in the Snake River drainage below Palisades Reservoir in Idaho and in Pacific Creek and other tributaries of the Snake River above the Gros Ventre River. It has been introduced to waters east of the Continental Divide (Baxter and Simon 1970). The Yellowstone cutthroat trout has been recorded from Teton, Park, Sheridan, Johnson, and Big Horn counties. This species may occur in suitable aquatic habitats of the Upper Tongue and Little Bighorn subwatersheds within the project study area. Suitable habitats include coldwater rivers, creeks, beaver ponds, and large lakes. Optimum water temperature generally may be 4.5 to 15.5 degrees Celsius (°C), but they probably were tolerant of much warmer temperatures historically in larger rivers. The management plan for this species is described in the Status and Management of Yellowstone Cutthroat Trout (WGFD 1999).

Goldeye. The goldeye occurs in the Upper Powder River, Crazy Woman Creek, Clear Creek, and Middle Powder River subwatersheds in the PRB and the Little Powder River subwatershed. It occurs in lake and stream habitats and can tolerate turbid conditions. Its food sources are insects, small fish, and other invertebrates. The spawning period is May and June (Baxter and Simon 1970).

Lake Chub. The lake chub inhabits foothill streams and lakes in the Upper Tongue and Little Powder River, and Upper Belle Fourche River subwatersheds. Lake chub feed on insect larvae, zooplankton, and algae. Lake populations usually show movements in the spring to tributary streams where they utilize rocky substrates.

Mountain Sucker. Six subwatersheds are inhabited by mountain sucker: Upper Tongue River, Middle Fork River, South Fork Powder River, Crazy Woman Creek, Middle Powder River, and Little Powder River. Surveys conducted in 2002 collected this species in the Powder River (WGFD 2003). The mountain sucker utilizes a variety of habitats such as larger streams, rivers, lakes, and reservoirs with sand, gravel, or mud substrates. The species usually is associated with undercut banks, eddies, and pools with moderate current (Woodling 1985). Young prefer backwater areas and eddies. Food consists almost entirely of algae. Spawning takes place in early summer.

Silvery Minnow. The silvery minnow occurs in the Middle Powder River and Little Powder River sub-watersheds where it prefers relatively large clear streams. This species often occurs in the same streams as flathead chub. The primary food items are considered to be algae and detritus.

Sturgeon Chub. Within the study area, the Upper Powder River is the only subwatershed inhabited by sturgeon chub. This species was collected in a 2002 survey in the mainstem portion of the Powder River and several tributary draws (WGFD 2003). This species prefers swift currents in large, turbid rivers with sand or gravel-dominated bottoms (Lee et al. 1980; Baxter and Simon 1970). The primary food consists of bottom-dwelling invertebrates. Spawning is suspected to occur in late spring to mid-summer (Lee et al. 1980).

Plains Minnow. The plains minnow is found in nine of the study area subwatersheds (Upper Tongue River, Upper Powder River, South Fork Powder River, Salt Creek, Clear Creek, Middle Powder River, Little Powder River, Upper Cheyenne River, and Upper Belle Fourche River). This species was collected in a 2002 survey in the mainstem portion of the Powder River and several tributary draws (WGFD 2003). Plains minnow prefers slower-moving water and side-pools in turbid streams. Its diet mainly consists of algae and plant material. The spawning period ranges from late spring into summer (Baxter and Simon 1970).

2.4.4 Comparison to Previous Predictions

2.4.4.1 Terrestrial Wildlife

Wildlife habitat within the study area has been disturbed by various development activities associated with coal mines, other mines, power plants, transmission lines, pipelines, reservoirs, coal technology plants, railroads, CBNG, and conventional oil and gas. Reclamation has been completed within some of these disturbance areas, thereby helping to minimize the overall acreage of remaining habitat disturbance and the time for habitats to reestablish.

Predictions made in earlier EISs (BLM 1979, 1981) for development-related disturbance and reclamation activities in the PRB were compared in the Coal Development Status Check (BLM 1996) to actual 1990 and 1994 disturbance and reclamation data. Based on the data in the 1996 document, actual disturbance and reclamation acreages affecting wildlife habitats in 1994 were 73,321 and 21,964, respectively. In comparison, the existing disturbance acreage affecting wildlife habitats in 2003 (based on GIS analysis) was 121,890 (ENSR 2005b). Based on the Task 2 database, approximately 136,284 acres of previously disturbed wildlife habitat had been reclaimed (ENSR 2005a).

2.6.3.1 Fisheries

Predictions relative to potential future impacts to fish species or other aquatic communities were not presented in the Coal Development Status Check (BLM 1996) or earlier EISs (BLM 1979, 1981) for the Wyoming PRB.

2.6.3.2 Special Status Species

Special status wildlife species habitat impact comparisons to earlier predictions are the same as described above for general wildlife.

Predictions relative to potential future impacts to sensitive aquatic species were not presented in the Coal Development Status Check (BLM 1996) or earlier EISs (BLM 1979, 1981) for the Wyoming PRB.

2.5 Grazing

2.5.1 Key Issues

Key issues for grazing and other agricultural uses include:

- Temporary and permanent loss of Animal Unit Months (AUMs)
- Temporary and permanent loss of water-related range improvements
- Temporary and permanent loss of other range improvements
- Increased number and distribution of livestock water sources (i.e., artificially created creeks and ponds) as a result of water being discharged from oil, gas, and mine development operations

2.5.2 Study Area

The study area for grazing and agricultural uses includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (see **Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area (see **Figure 1-3**).

2.5.3 Current Conditions

Livestock grazing is one of the primary land uses within the PRB study area since the majority of the area consists of rangeland, most of which is privately owned. Livestock grazing also occurs on lands administered by the BLM, USFS, and State of Wyoming. BLM-administered rangeland within the study area is managed by the Buffalo Field Office (Sheridan, Johnson, and Campbell counties) and Casper Field Office (northern portion of Converse County). USFS-administered rangeland within the study area is part of the TBNG, which is managed by the Douglas Ranger District. A summary of the number of allotments, lessees, and AUMs on federally-administered lands in the study area is presented in **Tables 2.5-1**. Discussions relative to rangeland administered by the various BLM and USFS offices in the study area are presented below. State-administered rangeland is leased for livestock grazing and is managed by the State of Wyoming.

2.5.3.1 BLM-administered Rangeland

Livestock grazing that occurs on BLM-administered rangeland in the Buffalo Field Office area includes 470 grazing allotments, which cover approximately 798,000 acres with an associated 398 lessees and 420 grazing leases (**Figure 2.5-1**). The majority of BLM grazing allotments that occur in the study area are leased by one lessee, although several allotments are leased by two or more lessees. The majority of leases have yearlong authorization, which means the lessees have the option to use the public lands when they choose during the year; however, it does not allow for year-round grazing. A small percentage of lessees choose to utilize rangeland on a yearlong basis. A small number of the allotments include large parcels of public rangeland that are divided into numerous pastures. Livestock grazing within these allotments occurs on a rotational basis.

SHERIDAN COUNTY

CAMPBELL COUNTY

JOHNSON COUNTY

CONVERSE COUNTY

DAYTON

SHERIDAN

BUFFALO

GILLETTE

WRIGHT

KAYCEE

Burlington Northern RR

Union Pacific RR

PP&L RR

I-90

I-25

14

14/16

15

16

59

387

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

Grazing Allotments

- TBNG allotments
- BLM Buffalo Field Office allotments
- BLM Casper Field Office allotments

WYOMING

N

W E

S

0 5 10 15 Miles

0 5 10 15 Kilometers

Source: BLM 2003a, 2004; Thunder Basin Coal Company

Powder River Basin Coal Review

Figure 2.5-1

Grazing Allotments

2.5-2

6/20/05

Table 2.5-1
Rangeland Summary for Federally-administered Lands in the Study Area

Allotments, Lessees, and AUMs	BLM-administered Rangeland	USFS-administered Rangeland	Total
Number of Grazing Allotments	520	75	595
Acres of Rangeland	871,000	266,000	1,137,000
Number of Lessees	449	48	497
Number of Grazing Lessees	471	74	545
AUMs	132,775	51,373	184,148

Sources: Medders 2004; Nelson 2004; Schmitt 2004; and Stanton 2004.

The majority of ranch operations consist of cow/calf pairs (approximately 90 percent) and yearlings, and the remainder consist of sheep operations. Authorized livestock use within these grazing allotments total 105,152 AUMs. An AUM is the amount of forage necessary to support 1 cow and calf, or 5 sheep, for 1 month. There are no suspended AUMs on any of the allotments. The average stocking rate for the study area is 5 to 7 acres per AUM; however, it can vary widely based on annual precipitation levels.

Livestock grazing that occurs on BLM-administered rangeland in the Casper Field Office area includes 50 grazing allotments, which cover approximately 73,000 acres with an associated 51 lessees and 51 grazing leases. The majority of the BLM grazing allotments that occur in the study area are leased by one lessee, although one allotment is leased by two lessees. All of the leases have yearlong authorization. A small percentage of lessees choose to utilize rangeland on a yearlong basis. A small number of the allotments include large parcels of public rangeland that are divided into numerous pastures. Livestock grazing within these allotments occurs on a rotational basis despite the fact that the lease often authorizes use for the entire year.

All of the ranch operations consist of cow/calf pairs or sheep operations. Authorized livestock use within these grazing allotments total 27,623 AUMs. There are no suspended AUMs on any of the allotments. The average stocking rate for the study area is 5 to 6 acres per AUM, but can vary widely based on annual precipitation levels.

2.5.3.2 USFS-administered Rangeland

Livestock grazing that occurs on USFS-administered rangeland in the southern portion of the TBNG includes entire or partial portions of 60 grazing allotments, which cover approximately 174,000 acres with an associated 34 lessees and 60 grazing leases (**Figure 2.5-1**). The majority of the USFS grazing allotments that occur in the study area are leased by one lessee, although several allotments are leased by two or more lessees (i.e., community allotments). Within these community allotments, lessees use separate pastures or in rare instances utilize the same pasture at different times of the year. The majority of leases have yearlong authorization. A small percentage of lessees choose to utilize rangeland on a yearlong basis. A small number of allotments include large parcels of public rangeland that are divided into numerous pastures.

Livestock grazing within these allotments occurs on a rotational basis despite the fact that the lease often authorizes use for the entire year.

The majority of ranch operations consist of cow/calf pairs and yearlings, and, to a lesser extent, sheep. Authorized livestock use on the grazing allotments total 37,573 AUMs. The average stocking rate for the study area is 4.5 acres per AUM, but can vary widely based on annual precipitation levels.

Livestock grazing that occurs on USFS-administered rangeland in the northern portion (i.e., Spring Creek Unit north of Gillette, Wyoming) of the TBNG includes entire or partial portions of 15 grazing allotments, which cover approximately 92,000 acres with an associated 14 lessees and 14 grazing leases (**Figure 2.5-1**). The majority of USFS grazing allotments that occur in the study area are leased by one lessee, although several allotments are leased by two or more lessees (i.e., community allotments). Within these community allotments, lessees use separate pastures or in rare instances utilize the same pasture at different times of the year. The majority of leases have yearlong authorization. A small percentage of lessees choose to utilize rangeland on a yearlong basis. A small number of allotments include large parcels of public rangeland that are divided into numerous pastures. Livestock grazing within these allotments occurs on a rotational basis despite the fact that the lease often authorizes use for the entire year.

The majority of ranch operations consist of cow/calf pairs (89 percent) and sheep (10 percent). Horses also utilize rangeland within this area but only comprise 1 percent of all grazing within the area. Authorized livestock use on the grazing allotments total 13,800 AUMs. The average stocking rate for the study area is 3.5 to 4.0 acres per AUM, but can vary widely based on annual precipitation levels.

2.5.3.3 Range Improvements

A wide array of range improvements have been completed on the allotments in the PRB study area to better control livestock for management purposes. These range improvements include fences, cattle guards, weed control, erosion control, prescribed burns, reclaimed areas, springs, water pipelines, reservoirs, electric- and windmill-powered wells, and access roads. Mapped locations for all of the improvements within the study area are not available.

2.5.3.4 Existing Impacts

Based on GIS analysis, the existing surface disturbance associated with development activities in the study area (as of the end of year 2003) have resulted in the loss of approximately 56,788 acres of rangeland, 36,265 acres of which occur on BLM-administered allotments and 20,523 acres which occur on USFS-administered allotments. Approximately 1,912 acres of the existing disturbance on the BLM-administered allotments is related to coal mine development (ENSR 2005b). The majority of surface disturbance in the study area has occurred on private property. Based on an average stocking rate of 6.0 acres per AUM on BLM-administered allotments in the study area and an average stocking rate of 4.0 acres per AUM on USFS-administered allotments, existing development-related disturbance has resulted in the loss of 6,044 and 5,130 AUMs, respectively.

2.5.4 Comparison to Previous Predictions

Predictions relative to potential future impacts to grazing were not presented in the Coal Development Status Check (BLM 1996) or earlier EISs (BLM 1979, 1981) for the Wyoming PRB.

2.6 Cultural Resources and Native American Concerns

2.6.1 Key Issues

Cultural resources are managed under Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended. The Section 106 process has three phases: 1) an identification phase, in which federal agencies attempt to identify all important resources; 2) an evaluation phase, in which known resources are evaluated to determine if they are eligible for inclusion on the National Register of Historic Places (NRHP); and 3) a mitigation phase, in which impacts to eligible resources are reduced or eliminated.

Due to the historic emphasis on identifying and evaluating individual sites, the general lack of systematic cultural resource distribution data, and a generally conservative approach among cultural resources specialists and land managers, the Section 106 process is largely reactive. Cultural resources studies are conducted on an individual basis as each lease, road, pipeline corridor, or other action is proposed and subsequently evaluated. Under the current process, it is not possible to predict the type of resources that will be identified within the PRB, potential impacts of development, and what measures will be necessary to mitigate potential impacts. Currently, the Wyoming State Historic Preservation Office (SHPO) is developing a tool to help identify locations where the geology is suitable for buried prehistoric archaeological sites within the Powder River and Tongue River hydrologic basins. The tool will help identify areas that could require construction monitors or subsurface testing to determine site eligibility, but it will not replace the need for Class III cultural resource inventory. This study does not take into account historic period sites such as trails, homesteads, and other locations of human activity by Euro Americans.

2.6.2 Study Area

The study area for cultural resources includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (see **Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area (see **Figure 1-3**). The subwatersheds in the study area are shown in **Figure 1-4**. Approximately 17 percent of the study area has been investigated for cultural resources, primarily in the eastern portion of the PRB.

2.6.3 Current Conditions

The majority of data presented here is based on a file search conducted through the Wyoming Cultural Records Office database in late March 2001 (BLM 2003a). The file search covered Campbell, Converse, Johnson, and Sheridan counties through the year 2000. The database of cultural resource survey reports, cultural resource sites, and isolated finds contained 8,120 sites and 2,831 isolated finds. Of the total cultural resource survey reports reviewed during the file search, 2,359 survey reports were completed prior to 1980 when statewide standards were implemented for cultural resource investigations and reporting. Some of those earlier reports were not considered adequate by current standards and were reviewed individually to evaluate their adequacy. Nonetheless, they provided information that otherwise might not be available on the

nature and distribution of prehistoric and historic resources. At the time of the file search, approximately 10 percent of the study area had been inventoried at the Class III level for cultural resources. Inventory coverage was strongly concentrated in the eastern half of the study area. This concentration of coverage was a result of nearly all of the cultural resources work being done in relation to coal development. In addition to cultural resource inventory, mitigation and data recovery were undertaken as a result of coal development.

Currently, the Wyoming SHPO is preparing a regional database of all recorded cultural resources located in the PRB. The database includes, but is not limited to, the number of sites and their location, site types, recordation date, report author, and each site's NRHP eligibility status. Information obtained from the database indicates that a total of 1,339,122 acres (17 percent) of the study area has been inventoried to Class III standards. Similar to the file search results, inventories are concentrated in the eastern half of the study area as a result of cultural work done for coal development. Mitigation and data recovery also have been undertaken in the basin as a result of coal development. Oil and gas, including CBNG, are extending inventories more evenly across the basin; however, data recovery is lagging because oil and gas development is designed flexibly to avoid important cultural resources.

This cultural resources section has been organized below in chronological order, with the results of the file search presented first, followed by the current information obtained from the SHPO.

2.6.3.1 Cultural Resources

Cultural resource sites are defined as discrete locations of past human activity, which can include artifacts, structures, works of art, landscape modifications, and natural features or resources important to history or cultural tradition. These sites can include extensive cultural landscapes, such as farm or ranch landscapes; linear landscapes, such as historic trails with associated towns, forts and way stations, or railroad landscapes; and traditional use areas. For the purposes of this analysis, important sites are those that would require additional consideration. These important sites include those that are listed on, determined eligible for, or recommended eligible for the NRHP under the Criteria for Evaluation (36 Code of Federal Regulations [CFR] § 60.4) or National Landmarks, and sites that have not been evaluated. Unevaluated sites are considered potentially eligible until they are evaluated and determined not eligible to the NRHP; therefore, these sites require avoidance or additional investigation.

Results of the File Search

Prehistoric Sites. All recognized prehistoric cultural periods, from Clovis through Protohistoric (about 11,500 to 200 years ago), are represented in the study area. The broad prehistoric chronological periods identified in this region are:

- Paleoindian Period (11,500 to 8,000 years ago)
- Early Plains Archaic (8,000 to 5,000 years ago)
- Middle Plains Archaic (5,000 to 2,500 years ago)
- Late Plains Archaic (2,500 to 1,500 years ago)
- Late Prehistoric and Protohistoric (1,500 to 200 years ago)

The earliest prehistoric cultural periods, Paleoindian through Early Plains Archaic, are represented by only a small number of sites. Archaic and later prehistoric period sites (Archaic to Protohistoric) are represented in increasing numbers as a result of higher populations through time and better preservation of more recent sites (**Table 2.6-1**). Important prehistoric site types in the region include artifact scatters, stone circles, faunal kill and processing sites, rock alignments and cairns, and stone material procurement areas (**Table 2.6-2**).

Artifact scatters dominate prehistoric sites in the study area. When there is adequate information to evaluate these types of sites, most are evaluated as not eligible. However, complex sites and sites with buried levels and dateable materials or artifacts can yield important information. Prehistoric camps are a combination of artifacts and features, or a range of artifact types. These sites are more often field evaluated as eligible than are simple artifact scatters. The small categories of multi-component/stratified, habitation features, rock features, bone beds/scatters, and rock art are high-profile categories that are very often evaluated as eligible. Bone beds and stratified sites that are key in understanding all periods of Plains prehistory occur in the study area. Subwatersheds where there have been more studies and more follow-up studies, such as Antelope Creek, Upper Cheyenne, and Upper Belle Fourche, have a lower proportion of unevaluated sites. Areas within some of the subwatersheds have more varied habitats, or conditions more conducive to preservation, and are very rich in significant prehistoric sites. These areas include the Upper Tongue, Middle Fork Powder, lower Antelope Creek Drainage, and eastern portions of the Upper Belle Fourche.

Table 2.6-1
Summary of Prehistoric Sites by Subwatershed

Subwatershed	Paleoindian	General Archaic	Early Archaic	Middle Archaic	Late Archaic	Late Prehistoric	Protohistoric	Total	Total percent
Upper Tongue River	2	2	2	5	8	20	4	43	3.6
Middle Fork Powder River	9	5	4	20	32	52	1	123	10.2
North Fork Powder River						1		1	0.1
Upper Powder River	4	11	2	23	31	75	1	147	12.2
South Fork Powder River					2	3		5	0.4
Salt Creek					1	1		2	0.2
Crazy Women Creek	1				8	6	2	17	1.4
Clear Creek	4			2	3	8		17	1.4
Middle Powder River	1	2		3	7	13		26	2.1
Little Powder River	9	10	5	21	51	96	12	204	16.9
Antelope Creek	11	5	18	25	49	86	4	198	16.4
Upper Cheyenne River	9	15	4	23	47	70	4	172	14.2
Total (sites)	**59**	**66**	**40**	**157**	**299**	**545**	**42**	**1,208**	**100**
Total (percent)	**4.8**	**5.5**	**3.3**	**13.0**	**24.8**	**45.1**	**3.5**	**100**	**--**

Source: BLM 2003a.

Note: Data were available for Campbell, Johnson, and Sheridan counties only. Some subwatersheds are not listed, and others have only minimal data.

Table 2.6-2
Prehistoric Site Types by Subwatershed

Subwatershed	Evaluation	Artifact Scatter[1]	Camp[2]	Multi-Component	Habitation Features[3]	Rock Features[4]	Bone[5]	Rock Art	Lithic Source	Features Only	Human Bone	Unknown	Total	Percentage[6]
Little Bighorn River	Eligible	0	0	0	0	0	0	0	0	0	0	0	0	0
	Unevaluated	2	0	0	0	0	0	0	0	0	0	0	2	66.7
	Not Eligible	1	0	0	0	0	0	0	0	0	0	0	1	33.3
	Total	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**<0.1**
Upper Tongue River	Eligible	3	8	0	1	0	0	0	0	0	0	0	12	5.6
	Unevaluated	69	41	1	25	4	3	2	8	3	0	0	156	72.9
	Not Eligible	26	12	0	4	3	0	0	1	0	0	0	46	21.5
	Total	**98**	**61**	**1**	**30**	**7**	**3**	**2**	**9**	**3**	**0**	**0**	**214**	**4.0**
Middle Fork Powder River	Eligible	24	78	0	6	2	2	5	8	0	0	0	125	29.4
	Unevaluated	66	41	0	15	5	2	2	12	0	1	1	145	34.1
	Not Eligible	77	63	0	2	4	0	0	9	0	0	0	155	36.5
	Total	**167**	**182**	**0**	**23**	**11**	**4**	**7**	**29**	**0**	**1**	**1**	**425**	**7.7**
North Fork Powder River	Eligible	0	1	0	0	0	0	0	0	0	0	0	1	25.0
	Unevaluated	2	0	0	0	0	0	0	0	0	0	0	2	50.0
	Not Eligible	1	0	0	0	0	0	0	0	0	0	0	1	25.0
	Total	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**<0.1**
Upper Powder River	Eligible	1	43	0	2	0	6	0	0	0	0	0	52	6.5
	Unevaluated	124	81	1	22	0	3	0	5	4	0	0	240	30.0
	Not Eligible	288	199	0	12	4	2	0	2	2	0	0	509	63.5
	Total	**413**	**323**	**1**	**36**	**4**	**11**	**0**	**7**	**6**	**0**	**0**	**801**	**15**

Table 2.6-2 (Continued)

Subwatershed	Evaluation	Artifact Scatter[1]	Camp[2]	Multi-Component	Habitation Features[3]	Rock Features[4]	Bone[5]	Rock Art	Lithic Source	Features Only	Human Bone	Unknown	Total	Percentage[6]
South Fork Powder River	Eligible	2	0	0	0	0	1	0	0	0	0	0	3	17.4
	Unevaluated	4	5	0	2	0	0	0	0	1	0	0	12	52.2
	Not Eligible	4	3	0	0	0	0	0	0	0	0	0	7	30.4
	Total	**10**	**8**	**0**	**2**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**22**	**0.4**
Salt Creek	Eligible	2	1	0	1	0	0	0	0	0	0	0	4	6.2
	Unevaluated	10	14	0	7	3	0	1	1	0	0	0	36	55.4
	Not Eligible	16	4	0	0	5	0	0	0	0	0	0	25	38.4
	Total	**28**	**19**	**0**	**8**	**8**	**0**	**1**	**1**	**0**	**0**	**0**	**65**	**1.2**
Crazy Woman Creek	Eligible	3	5	0	2	0	1	1	0	0	0	0	12	12.2
	Unevaluated	14	15	0	12	0	0	1	2	0	0	1	45	45.9
	Not Eligible	19	10	0	7	4	0	0	0	0	1	0	41	41.9
	Total	**36**	**30**	**0**	**21**	**4**	**1**	**2**	**2**	**0**	**1**	**1**	**98**	**1.8**
Clear Creek	Eligible	3	6	0	3	0	0	0	0	0	0	0	12	9.7
	Unevaluated	10	14	0	27	2	3	0	2	1	0	1	60	48.4
	Not Eligible	24	10	0	5	9	0	0	4	0	0	0	52	41.9
	Total	**37**	**30**	**0**	**35**	**11**	**3**	**0**	**6**	**1**	**0**	**1**	**124**	**2.3**
Middle Powder River	Eligible	2	1	0	0	0	0	0	0	0	0	0	3	2.3
	Unevaluated	33	37	0	6	0	0	0	2	0	0	0	78	61.5
	Not Eligible	40	5	0	2	0	2	0	0	0	0	0	49	36.2
	Total	**75**	**43**	**0**	**8**	**0**	**2**	**0**	**2**	**0**	**0**	**0**	**130**	**2.4**
Little Powder River	Eligible	11	40	0	16	1	5	0	0	0	0	1	74	13.6
	Unevaluated	66	21	1	26	2	3	0	3	0	0	0	122	22.4
	Not Eligible	256	33	0	29	9	7	0	12	1	1	1	349	64.0
	Total	**333**	**94**	**1**	**71**	**12**	**15**	**0**	**15**	**1**	**1**	**2**	**545**	**9.9**

Table 2.6-2 (Continued)

Subwatershed	Evaluation	Artifact Scatter[1]	Camp[2]	Multi-Component	Habitation Features[3]	Rock Features[4]	Bone[5]	Rock Art	Lithic Source	Features Only	Human Bone	Unknown	Total	Percentage[6]
Little Missouri River	Eligible	0	1	0	0	0	0	0	0	0	0	0	1	5.3
	Unevaluated	2	1	0	2	0	0	0	0	0	0	0	5	26.3
	Not Eligible	6	7	0	0	0	0	0	0	0	0	0	13	68.4
	Total	**8**	**9**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**19**	**0.3**
Antelope Creek	Eligible	53	122	1	20	0	2	0	2	2	1	0	203	23.0
	Unevaluated	125	49	0	28	14	3	1	0	5	1	0	226	25.6
	Not Eligible	298	104	0	38	11	1	0	2	0	0	1	455	51.4
	Total	**476**	**275**	**1**	**86**	**25**	**6**	**1**	**4**	**7**	**2**	**1**	**884**	**16.1**
Dry Fork Cheyenne River	Eligible	1	32	0	11	1	1	0	1	0	0	0	47	11.1
	Unevaluated	58	58	0	59	50	2	0	1	2	0	0	230	54.4
	Not Eligible	90	31	0	11	7	3	0	4	2	0	0	148	34.5
	Total	**149**	**121**	**0**	**81**	**58**	**6**	**0**	**6**	**4**	**0**	**0**	**425**	**7.7**
Upper Cheyenne River	Eligible	8	28	0	5	2	3	0	0	0	1	0	47	9.4
	Unevaluated	51	30	1	19	2	2	0	5	0	0	0	110	21.2
	Not Eligible	289	47	1	12	5	4	0	3	0	0	0	361	69.7
	Total	**348**	**105**	**2**	**36**	**9**	**9**	**0**	**8**	**0**	**1**	**0**	**516**	**9.4**
Lightning Creek	Eligible	3	15	0	2	0	0	0	0	0	0	0	20	8.8
	Unevaluated	80	29	0	12	4	3	0	1	0	0	0	129	56.6
	Not Eligible	54	19	0	4	2	0	0	0	0	0	0	79	34.6
	Total	**137**	**63**	**0**	**18**	**6**	**3**	**0**	**1**	**0**	**0**	**0**	**228**	**4.1**
Upper Belle Fourche River	Eligible	15	26	0	25	2	0	0	0	0	0	0	68	9.0
	Unevaluated	109	33	1	53	23	8	0	7	5	0	1	240	31.7
	Not Eligible	284	88	0	63	10	1	0	3	0	0	0	449	59.3
	Total	**408**	**147**	**1**	**141**	**35**	**9**	**0**	**10**	**5**	**0**	**1**	**757**	**13.8**

Table 2.6-2 (Continued)

Subwatershed	Evaluation	Artifact Scatter[1]	Camp[2]	Multi-Component	Habitation Features[3]	Rock Features[4]	Bone[5]	Rock Art	Lithic Source	Features Only	Human Bone	Unknown	Total	Percentage[6]
Middle North Platte River	Eligible	2	19	0	7	0	1	0	0	0	0	0	29	11.9
	Unevaluated	21	36	0	48	17	0	0	0	1	0	0	123	50.6
	Not Eligible	40	31	0	8	5	1	0	5	0	0	0	91	37.5
	Total	**63**	**86**	**0**	**63**	**22**	**2**	**0**	**5**	**1**	**0**	**0**	**242**	**4.4**
Total Eligible Sites		135	426	1	102	8	22	6	11	2	2	1	716	13.0
Total Unevaluated Sites		846	505	5	363	126	32	7	49	22	2	4	1,961	35.6
Total Sites		2,792	1,597	7	661	212	75	13	105	29	6	7	5,504	100
Percent of Total Sites		**50.8**	**29.0**	**0.1**	**12.0**	**3.9**	**1.4**	**0.2**	**1.9**	**0.5**	**0.1**	**0.15**	**100**	

[1]Artifact scatters are predominantly lithic (that is, chipped stone tool) scatters in this region, but also include ground stone, ceramics, and composite artifact scatters.
[2]Camps include sites encoded as open camp, habitation, or artifacts and features.
[3]Habitation features include stone circles, open architecture, structures, lodges, and rockshelters. The most common of the latter are stone circles.
[4]Rock features include cairns, hunting blinds, rock alignments, and other non-habitation rock features.
[5]Bone includes bone beds, bone scatters, kill sites, and butchering sites.
[6]Percent is given as percent eligible for each subwatershed and then percent of total sites represented by the subwatershed.

Source: BLM 2003a.

Sites are areas where evidence of one or more episodes of past human activity is visible on the landscape. Prehistoric site densities vary from extremely high in some settings, such as certain ridgetops and areas near larger, more reliable drainages, to nonexistent in other settings. The factors affecting these differences in density are not always readily apparent. If a location is used by a large number of people or repeatedly over a long period, lost or discarded cultural materials would accumulate. If the landform remains stable over time and is not degraded, deeply buried, or mechanically disturbed, the site would remain visible. Site density is influenced by the size and number of groups that used the area and the availability or density of resources. High site densities often are associated with locations that have a predictable abundance of particular resources, locations that have a moderate abundance of several distinct resources, or locations that have access to several resource areas. Another factor that is frequently noted in site location is proximity to a reliable source of water. Other factors may be responses to seasonal conditions, such as winter camps with minimal snow accumulation that are sheltered from the wind, or summer camps on higher benches away from swarming bugs.

In the Protohistoric and early historic periods, the PRB was the territory of numerous tribes including, the Arikara, Crow, Lakota/Dakota, Arapaho, Kiowa, Comanche, Blackfeet, Cheyenne, and Shoshone. The region was a crossroads for many different Plains tribes, some of which used the area on a regular basis, and others that entered the region occasionally for particular resources. Numerous confrontations occurred in the area among tribal groups and with Euroamerican settlers and emigrants passing through to other areas.

Historic Sites. The historic period of the area falls within the last 200 years, and begins with transient, widely separated expeditions by explorers and fur traders. The major historic periods are:

- Early Historic (AD 1800 to 1842)
- Pre-territorial (AD 1842 to 1868)
- Territorial (AD 1868 to 1890)
- Expansion (AD 1890 to 1920)
- Depression (AD 1920 to 1939)
- Modern (AD 1939 to present)

Exploration and the establishment of the Rocky Mountain fur trade intensified Euroamerican presence in the PRB in the early 1800s. After the decline of the fur trade in the late 1830s, several of the major emigrant trails of the 1840s and 1850s passed through the southern end of the study area along the North Platte corridor. Fort Laramie served as a major supply point along the Oregon, California, and Mormon trails and was a focal point for overland emigrants. This famous fur-trading post was purchased by the U.S. government in 1849 to become the second regular military installation along the Oregon and California trails.

In 1851, Fort Laramie was the site of an historic general treaty with the Plains tribes. The Fort Laramie Treaty Council of 1851 was the greatest gathering of Plains tribes ever, and though it was considered a success, it did not completely eliminate hostilities. Fort Laramie provided many important services to overland immigrants, such as protection, a place to stay in winter, health care, and mail (Unruh 1982).

With the emergence of the Montana gold fields in the 1860s, trails were established through the Basin. In 1863, a group of 46 wagons attempted the first alternative of the Bozeman Trail. This first

wagon train was turned back by Cheyenne and Lakota near present-day Buffalo. Three wagon trains followed the route in 1864. One of the latter wagon trains, often called the Townsend Train, was attacked by Cheyenne near the Powder River, and several emigrants were killed. There were several competing expeditions from 1864 through 1866 to identify a better route for a trail to the Montana gold fields and many gold seekers set out on their own without an established trail. Among the competing expeditions were the Sawyer expeditions of 1864, and 1865-1866, which attempted to establish a trail through the PRB south of Gillette and through Sheridan. The expeditions were harassed by groups of Arapaho, Cheyenne, and Lakota, and on several occasions were pinned down for days or weeks. No viable trail was established across the middle of the basin due to Indian raids, unreliable water sources, and difficult terrain.

The Bozeman Trail along the western edge of the basin proved more viable. There were many documented confrontations between native tribes and Euroamericans along the Trail. Among the more famous were the Wagon Box Fight, Fetterman Fight, and Crazy Woman Battle. The area around the crossing at Crazy Woman Creek was the site of many other skirmishes as well. Despite sustained problems with the native groups, the Bozeman Trail was used sporadically, and military forts were established to protect the wagon trains, including Fort Reno and Fort Phil Kearney. An agreement made by the U.S. with several bands of Sioux and Arapahos, the 1868 Treaty of Fort Laramie brought temporary peace to the northern plains following "Red Cloud's War" of 1866-68.

The 1868 Treaty of Fort Laramie had four parts. The first pledged both sides to peace. The second reserved the area west of the Missouri River and east of the Rockies for the "absolute and undisturbed use" of the Sioux. The third and longest section described several mechanisms by which the government would support the tribes: it would establish schools, provide seed and clothing for Indian farmers, and set up agencies for the distribution of aid. The treaty further stipulated that no revisions would be made in the agreement without the approval of three-quarters of the adult males of the tribe. Finally, the treaty recognized the Bozeman Trail area as "unceded Indian territory" where whites would not be allowed to settle and within which there would be no military posts (Encyclopedia of North American Indians 2004).

East of the study area, the discovery of gold in the Black Hills by Lieutenant Colonel Custer in 1874 stimulated an influx of gold seekers and settlers into the Black Hills and PRB. The influx into the sacred Black Hills enraged the tribes, particularly the Cheyenne and Lakota. The tribes refused to negotiate or come in and speak with the agencies. In 1876, the United States launched major campaigns against the “hostiles” with troops out of Fort Fetterman, near present-day Douglas, following the Bozeman Trail north. As a result of these campaigns, the tribes were driven out of the PRB and the Bozeman Trail was reopened.

The arrival of the railroad and the establishment of Cheyenne in 1867 made the PRB more accessible, and settlers began to filter in. In 1878 and 1879, mail and stage service was established roughly following the Bozeman Trail.

The passage of the Homestead Act in 1862 was the culmination of more than 70 years of controversy over the disposition of public lands. The Act, which became law on January 1, 1863, allowed anyone to file for a quarter-section of free land (160 acres). The entry of the Burlington Railroad in the 1890s made travel to the region quicker and less hazardous, and for a time homesteaders and small ranches prevailed. In 1909, the Enlarged Homestead Act was passed allowing larger homestead entries, and an additional surge of homesteaders and small ranchers

entered the region. The Stock Raising Homestead Act of 1916 followed, and with the end of the First World War, many veterans moved west to claim vacant land. The increase in settlement was brought to an end by droughts and agricultural recession in the 1920s and the Great Depression of the 1930s.

With the establishment of the railroads in the early 1890s, coal mining began emerging as an important element of the regional economy. Sheep and cattle production have remained important elements of the regional economy, but they have been surpassed by mineral and energy development. The onset of the First World War increased the market for oil and coal, and these industries expanded. Energy exploration and production were not strongly affected by the agricultural recession of the 1920s. However, the depression of the 1930s did suppress the energy market until the outbreak of the Second World War.

The reader is referred to the following document for a more in-depth description of the culture history of the PRB: Final Environmental Impact Statement and Proposed Plan Amendment for the PRB Oil and Gas Project (BLM 2003a).

Historic site categories documented for the study area are based on broad historic themes. The site categories are Rural, Urban, Mining, Transportation, Military, Exploration, and Communication. Each of these site categories and the types of sites they include are shown in **Table 2.6-3**. Evaluation of the importance of historic sites, districts, and landscapes must consider aspects of both theme and period in assessing the historic character and contributing attributes of the resources.

Rural/agrarian sites dominate known historic sites, because that is where the majority of systematic surveys have been conducted. These include homesteads, farms, ranches, agrarian and ranching features, irrigation features, and rural residences. The principal exception is the Upper Tongue River subwatershed, in which a large number of urban buildings and structures have been documented in Sheridan. The next most common site type is transportation features, which include trails, roads, bridges, railroads, stage stations, railroad stations, and related structures or features. Where historic military sites, early exploration sites, and early transportation sites have been recognized and documented, most are considered significant because of their associations with significant historic events. The Bozeman Trail, its several variants, and related sites, were highly significant in western history and retain a large number of well preserved segments. The Outlaw Cave/Red Wall area of the Middle Fork Powder River is rich in prehistoric caves and rockshelters, premiere prehistoric rock art sites, prehistoric stone features, and historic sites that figure prominently in Western lore. The proportion of significant historic sites is high in most categories, and these sites require additional work beyond basic field recording. In addition, many of the historic sites are unevaluated and require additional background or context research to assess their eligibility.

Native American Traditional Cultural Places

General ethnographies of the Lakota, Crow, Mandan, Hidatsa, Arikara, Cheyenne, Arapaho, Shoshone, and other tribes that may have had traditional ties to this region do not provide information on specific resources in the study area that are likely to be traditional cultural concerns because these resources are considered confidential by the tribes. There are certainly prominent and identifiable places to the west in the Big Horn Mountains and to the east in the Black Hills area.

Table 2.6-3
Historic Site Types by Historic Theme and Subwatershed

Subwatershed	Evaluation	Rural	Urban	Mining	Transportation	Military	Exploration	Communication	Other	Unknown	Total	Percent
Little Bighorn River	Eligible	0	0	0	3	0	0	0	0	0	3	60
	Unevaluated	0	0	0	0	0	0	0	0	0	0	0
	Not Eligible	1	0	0	1	0	0	0	0	0	2	40
	Total	**1**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**5**	**0.2**
Upper Tongue River	Eligible	8	11	3	13	4	0	0	0	1	40	16.9
	Unevaluated	37	13	14	2	5	1	0	9	12	93	39.2
	Not Eligible	12	60	8	22	0	0	0	2	0	104	43.9
	Total	**57**	**84**	**25**	**37**	**9**	**1**	**0**	**11**	**13**	**237**	**10.5**
Middle Fork Powder River	Eligible	8	1	0	1	1	0	0	0	1	12	12.1
	Unevaluated	34	6	0	2	0	0	0	8	6	56	56.6
	Not Eligible	16	1	0	2	0	0	0	11	1	31	31.3
	Total	**58**	**8**	**0**	**5**	**1**	**0**	**0**	**19**	**8**	**99**	**4.4**
North Fork Powder River	Eligible	1	0	0	0	0	0	0	0	0	1	50
	Unevaluated	0	0	0	0	0	0	0	0	0	0	0
	Not Eligible	0	0	0	0	0	0	0	1	0	1	50
	Total	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**<0.1**
Upper Powder River	Eligible	10	0	0	13	2	0	0	3	1	29	8.5
	Unevaluated	74	1	2	3	4	1	0	10	23	118	34.7
	Not Eligible	120	0	2	13	0	1	0	49	8	193	56.8
	Total	**204**	**1**	**4**	**29**	**6**	**2**	**0**	**62**	**32**	**340**	**15.1**
South Fork Powder River	Eligible	1	0	0	1	0	0	0	1	0	3	18.8
	Unevaluated	1	1	0	0	0	3	0	1	1	7	43.7
	Not Eligible	2	0	0	4	0	0	0	0	0	6	37.5
	Total	**4**	**1**	**0**	**5**	**0**	**3**	**0**	**2**	**1**	**16**	**0.7**
Salt Creek	Eligible	0	0	0	2	0	0	0	0	0	2	7.1
	Unevaluated	6	0	0	2	0	0	0	0	1	9	32.2
	Not Eligible	5	0	1	6	0	0	0	5	0	17	60.7
	Total	**11**	**0**	**1**	**10**	**0**	**0**	**0**	**5**	**1**	**28**	**1.2**

Table 2.6-3 (Continued)

Subwatershed	Evaluation	Rural	Urban	Mining	Transportation	Military	Exploration	Communication	Other	Unknown	Total	Percent
Crazy Woman Creek	Eligible	1	0	0	6	1	0	0	1	0	9	12.7
	Unevaluated	18	1	2	2	0	2	0	3	1	29	40.8
	Not Eligible	17	0	1	8	0	0	0	5	2	33	46.5
	Total	**36**	**1**	**3**	**16**	**1**	**2**	**0**	**9**	**3**	**71**	**3.1**
Clear Creek	Eligible	16	8	0	6	3	0	0	1	1	35	19.7
	Unevaluated	32	12	4	5	0	0	0	4	12	69	38.7
	Not Eligible	15	10	3	39	0	0	2	5	0	74	41.6
	Total	**63**	**30**	**7**	**50**	**3**	**0**	**2**	**10**	**13**	**178**	**7.9**
Middle Powder River	Eligible	2	0	0	0	0	0	0	0	0	2	5.5
	Unevaluated	18	0	0	0	0	0	0	1	0	19	52.8
	Not Eligible	7	1	0	2	0	0	0	5	0	15	41.7
	Total	**27**	**1**	**0**	**2**	**0**	**0**	**0**	**6**	**0**	**36**	**1.6**
Little Powder River	Eligible	9	0	0	0	0	1	0	0	0	11	5.8
	Unevaluated	49	2	0	2	0	0	0	6	5	64	33.7
	Not Eligible	66	2	2	10	0	0	0	22	13	115	60.5
	Total	**124**	**4**	**2**	**12**	**0**	**1**	**0**	**29**	**18**	**190**	**8.4**
Little Missouri River	Eligible	0	0	0	0	0	0	0	0	0	0	0
	Unevaluated	3	1	0	1	0	0	0	1	1	7	70
	Not Eligible	2	0	0	0	0	0	0	0	1	3	30
	Total	**5**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**2**	**10**	**0.4**
Antelope Creek	Eligible	14	1	0	4	0	0	0	2	2	23	7.9
	Unevaluated	37	1	2	0	0	0	0	16	13	69	23.5
	Not Eligible	123	0	5	6	1	0	0	55	11	201	68.6
	Total	**174**	**2**	**7**	**10**	**1**	**0**	**0**	**73**	**26**	**293**	**13.0**
Dry Fork Cheyenne River	Eligible	3	0	0	2	0	0	0	1	0	6	4.1
	Unevaluated	50	0	0	3	0	0	0	20	7	80	54.8
	Not Eligible	32	0	1	4	1	0	0	18	4	60	41.1
	Total	**85**	**0**	**1**	**9**	**1**	**0**	**0**	**39**	**11**	**146**	**6.5**
Upper Cheyenne River	Eligible	4	0	0	1	0	0	0	3	0	8	4.8
	Unevaluated	13	0	0	2	0	0	0	7	8	30	18.0
	Not Eligible	85	0	1	7	0	0	0	35	1	129	77.2
	Total	**102**	**0**	**1**	**10**	**0**	**0**	**0**	**45**	**9**	**167**	**7.4**

Table 2.6-3 (Continued)

Subwatershed	Evaluation	Rural	Urban	Mining	Transportation	Military	Exploration	Communication	Other	Unknown	Total	Percent
Lightning Creek	Eligible	2	0	0	0	0	0	0	0	0	2	3.9
	Unevaluated	8	0	0	0	0	0	0	3	10	21	41.2
	Not Eligible	15	0	0	0	0	0	0	11	2	28	54.9
	Total	**25**	**0**	**0**	**0**	**0**	**0**	**0**	**14**	**12**	**51**	**2.3**
Upper Belle Fourche River	Eligible	17	0	0	5	3	0	0	1	1	27	8.6
	Unevaluated	37	1	4	4	0	0	0	9	18	73	23.3
	Not Eligible	130	3	4	10	0	0	0	47	19	213	68.1
	Total	**184**	**4**	**8**	**19**	**3**	**0**	**0**	**57**	**38**	**313**	**13.9**
Middle North Platte River	Eligible	0	0	0	4	0	0	0	0	0	4	5.6
	Unevaluated	34	0	0	1	0	0	0	8	1	44	61.1
	Not Eligible	14	0	0	4	0	0	0	4	2	24	33.3
	Total	**48**	**0**	**0**	**9**	**0**	**0**	**0**	**12**	**3**	**72**	**3.2**
Total Eligible Sites		96	21	3	61	14	1	0	14	7	217	9.6
Total Unevaluated Sites		451	39	28	29	9	7	0	106	119	788	35.0
Total Sites		1,209	137	59	228	25	9	2	395	190	2,254	100
Percent Total Sites		**53.6**	**6.1**	**2.6**	**10.1**	**1.1**	**0.4**	**<0.1**	**17.5**	**8.4**	**100**	

[1]Rural sites include small and large ranch/agrarian core complexes, outlining ranch/agrarian features (e.g., field barns, stock shelters, stock ponds or tanks, machinery hands), homesteads, and rural community buildings (e.g., grange halls, rural schools, and rural churches).
[2]Urban sites include outhouses, dance halls, saloons, parks, homes, hotels/lodges, stores, commercial buildings, power plants, and warehouses.
[3]Mining sites include mines, tipple, loadout, well field, and mining support.
[4]Transportation sites include overland migration corridor/emigrant trail, inscriptions, trail/stage route, freight road, airstrip, ferry, bridge, and railroad.
[5]Military sites include blockhouses, proving grounds, air base, missile silos, military camp, and weapons depot.
[6]Exploration sites include fur trade cabins, trading post, trade beads, and survey marker.
[7]Communication sites include telegraph/telephone lines, Pony Express Station, and transmission lines.
[8]Other sites include Civilian Conservation Corps Camp/conservation site, hatchery, monument, prison camp, lumber mill, timber camp, cabins, and burial/cemetery/grave.

Source: BLM 2003a.

Probably the most widely known examples would be the Big Horn Medicine Wheel and Devils Tower. The known sacred and traditional places offer some indications of the types of places valued by the Plains horse cultures in the historic period. However, any identification of sacred or traditional localities must be verified in consultation with authorized tribal representatives.

Conspicuous landmarks, prominences, and high locations were often held in reverence. It would be reasonable to assume that Pumpkin Buttes, several of the more distinctive or isolated buttes throughout the study area, and distinct rock formations in the Middle Fork and Red Wall country were traditionally important places. Some of these natural features may have associated rock art, cairns, offering sites, vision quest sites, or other tangible evidence of traditional importance, while others may be embedded in oral traditions.

Distinctive natural water bodies and confluences of flowing streams and rivers were considered by many tribes to be sources of power and inspiration and mirrors of the inner spirit. The presence of flowing water or bodies of water and high isolated locations such as buttes in close proximity to one another were sometimes considered especially powerful or close to the spirits. These kinds of locations were commonly used for fasting or vision quests. Some vision quest sites that were used repeatedly over the generations have physical features, such as cairns, small stone circles, offerings, small clusters of stone, or stone alignments, in addition to the character of their physical setting. When there is no physical evidence, vision quest sites are remembered through songs and preserved memories.

At a smaller scale, traditional rock art marks localities that were important or sacred to past populations, and the rock art itself is a traditional concern to most existing tribes. Similarly, images and designs engraved in stone, some rock alignments, and many ancient rock cairns, mark traditionally significant locations. Any location with cobble figures, unusually small or large stone circles or medicine wheels, geometric stone alignments, or prominent cairns should be considered a potential sacred or traditional site. Tribes also may consider alignments and cairns associated with more mundane functions such as trails and game drives to be sacred or traditionally important, and also may consider most archaeological sites to be traditional cultural places important to their tribal identity. Several of the tribes that have traditional ties to the study area consider “tipi rings” (i.e., stone circle sites) to be sensitive sites that may have spiritual or sacred associations. Traditional tribal concerns also can include traditional gathering areas for medicinal and ceremonial materials. The persistence of plants for food, material, and medicinal purposes, and their associated artifacts, are extremely important to the tribes.

SHPO Data

According to the SHPO database, 10,795 cultural sites have been identified in the study area. Of these, 5,871 (54 percent) are prehistoric sites, 2,664 (25 percent) are historic sites, 167 (1.6 percent) are multi-component sites, 51 (less than 1 percent) are sites of unknown cultural affiliation, unknown use, or with no information, and 2,042 (19.0 percent) sites are labeled as “not encoded.” The SHPO defines “not encoded” as those sites that have no field value entered in the database table. Artifact scatters, camps, habitation features, rock features, and lithic sources are the predominate prehistoric site type in the study area.

Artifact Scatters – Artifact scatters are predominantly scatters of stone tools and stone tool-making debris in the region, but they also include ground stone, ceramics, and composite artifact scatters.

These sites are important because they are often the only remnants indicating the presence of human activity. Artifact scatters may provide information on chronology, subsistence, technology, settlement patterns, and resource choices, and they help in understanding past lifeways.

Camps – Camps are predominantly sites with artifact scatters and features or a range of artifact types that indicate habitation of the area. These types of sites include open camps, habitation areas, or artifacts and features. Camps are more often evaluated in the field as eligible to the NRHP than artifact scatters. These sites are important because they have the potential to yield information about issues of settlement, subsistence, technology, chronology, and social organization by various prehistoric peoples.

Habitation Features – Habitation features are predominantly stone circle sites in the region, but also include open architecture, structures, lodges, and rockshelters. These sites are important because they can provide evidence of the range of habitation structural types and preferences and may provide information on settlement patterns, seasonal use of the area, social organization, and past lifeways.

Rock Features – Rock features are predominantly cairns, hunting blinds, and rock alignments, but they can include any non-habitation rock feature such as a medicine wheel. These sites are important because they may provide information on ceremonial uses in the area, subsistence, territorial markers, and cultural use of the landscape.

Lithic Source – Lithic source is a location used for acquisition of stone suitable for chipped stone tool manufacture. These locations may be areas of bedrock outcrops containing usable stone, or may be areas where pebbles, cobbles, or boulders of raw material have been deposited by past geological processes. These sites are important because they may provide information on resource choices and technology of prehistoric peoples. Some lithic material may be found quite far from its source. The distribution of culturally modified materials away from lithic source areas can provide important information on the movement or interaction of cultural groups over time.

Historic sites in the study area mainly consist of debris scatters, homesteads, ranching camps/features, cairns, transportation features (e.g., railroads, bridges, trails, and stage routes), and mines. Multi-component sites are predominantly artifact scatters and camps that contain evidence of use by different cultural groups or by the same group over different periods. The majority of not encoded sites are lithic scatters, open camps, stone circles, hearths, or quarries. Cairns and rock piles account for the majority of unknown sites.

The NRHP-eligibility status of documented sites can include, but is not limited to, recommended as not eligible for the NRHP, not eligible with SHPO concurrence, recommended as eligible for the NRHP, or eligible with SHPO concurrence. Due to the large number of sites in the study area, the sites have been categorized by prehistoric, historic, mulitcomponent, unknown, and not encoded, and each category lists the number of sites per eligibility status (**Tables 2.6-4** through **2.6-8**).

Table 2.6-4
NRHP Eligibility Status of Prehistoric Sites

Eligibility Status	Number of Prehistoric Sites
Destroyed	41
Eligible (SHPO Concur) Destroyed	6
Eligible/Consultant/No Review	316
Eligible/NRHP Keeper	72
Eligible (SHPO Concurrence)	616
Eligiblity Unknown	1,217
Keeper DOE/Destroyed	5
Listed on NRHP	3
No Eligible Info/Destroyed	3
No Eligibility Information	10
Noncontrib/Eligible SHPO Concur	7
Not Eligible/Consultant/No Review	1,970
Not Eligible/Destroyed	23
Not Eligible/SHPO Concur	1,519
Not Found/Unlocated	11
See Site Form for Eligibility	44
Uneval Segment/SHPO Concur Eligible	2
Unknown Eligiblity, Destroyed	6
Total	**5,871**

Table 2.6-5
NRHP Eligibility Status of Historic Sites

Eligibility Status	Number of Historic Sites
Contrib/Eligible SHPO Concur	9
Destroyed	8
Eligible (SHPO Concur) Destroyed	1
Eligible/Consultant/No Review	66
Eligible/NRHP Keeper	4
Eligible (SHPO Concurrence)	91
Eligiblity Unknown	476
Keeper DOE/Destroyed	4
Listed on NRHP	53
Listed on NRHP/Destroyed	2
National Landmark	3
No Eligibility Information	4
Noncontrib/Eligible SHPO Concur	32
Not Eligible/Consultant/No Review	1,089
Not Eligible/Destroyed	6
Not Eligible/SHPO Concur	777
Not Found/Unlocated	6
See Site Form for Eligibility	27
Uneval Segment/SHPO Concur Eligible	1
Unknown Eligiblity, Destroyed	5
Total	**2,664**

Table 2.6-6
NHRP Eligibility Status of Multicomponent Sites

Eligibility Status	Number of Multicomponent Sites
Eligible (SHPO Concur) Destroyed	3
Eligible/Consultant/No review	26
Eligible/NRHP Keeper	2
Eligible (SHPO Concurrence)	2
Eligiblity Unknown	10
No Eligibility Information	3
Not Eligible/Consultant/No Review	111
Not Eligible/SHPO Concur	10
Total	**167**

Table 2.6-7
NRHP Eligibility Status of Sites with Unknown Cultural Affiliation

Eligibility Status	Number of Unknown Sites
Elig/Consultant/No review	1
Eligible (SHPO Concurrence)	1
Eligiblity Unknown	17
Noncontrib/Elig SHPO Concur	1
Not Elig/Consultant/No Review	19
Not Eligible/SHPO Concur	11
Unknown Eligiblity, Destroyed	1
Total	**51**

Table 2.6-8
NRHP Eligibility Status of Not Encoded Sites

Eligibility Status	Number of Not Encoded Sites
Destroyed	11
Eligible/Consultant/No review	90
Eligible/NRHP Keeper	68
Eligible (SHPO Concurrence)	41
Eligiblity Unknown	440
Listed on NRHP	4
No Eligibility Information	8
Not Eligible/Consultant/No Review	652
Not Eligible/Destroyed	7
Not Eligible/SHPO Concur	19
See Site Form for Eligibility	700
Unknown Eligibility, Destroyed	2
Total	**2,042**

Source: Wyoming SHPO 2005.

2.6.3.2 Native American Concerns

The 1992 NHPA amendments place major emphasis on the role of Native American groups in the Section 106 review process. Subsequent revisions to the regulations of the Advisory Council on Historic Preservation (Council) published May 18, 1999, incorporate specific provisions for federal agencies to involve Native American groups in land or resource management decisions and for consulting with these groups throughout the process. Before making decisions or approving actions that could result in changes in land use, physical changes to lands or resources, changes in access, or alienation of lands, federal managers must determine whether Native American interests would be affected, observe pertinent consultation requirements, and document how this was done. The consultation record will be the federal agency's basis for demonstrating that the responsible manager has made a reasonable and good faith effort to obtain and consider appropriate Native American input in decision making.

Under Native American Consultation:

- The federal agency must consult with any Native American group that attaches religious and cultural significance to historic properties that may be affected by an undertaking regardless of location (Section 101[d][6][b]). Such Native American group is a consulting party.

- The federal agency must make a reasonable and good faith effort to identify Native American groups to be consulted.

- The federal agency must be respectful of tribal sovereignty in conducting consultation.

- The federal agency must recognize the government-to-government relationship.

- Historic properties of religious and cultural significance may be located on ancestral, aboriginal, or ceded lands of Native Americans.

- The Native American groups may enter into agreement with the federal agency regarding any aspect of tribal participation in the Section 106 review process. The agreement may provide the Native American groups with additional participation or concurrence in agency decisions under Section 106 provided that no modification may be made in the roles of other parties without their consent.

As a formal participant in the national historic preservation program, a tribe may assume official responsibility for a number of functions aimed at the preservation of significant historic properties. Those functions include identifying and maintaining inventories of culturally significant properties, nominating properties to national and tribal registers of historic places, conducting Section 106 reviews of federal agency projects on tribal lands, and conducting educational programs on the importance of preserving historic properties.

When an undertaking occurs on or affects historic properties on tribal lands, federal agencies must consult with a representative designated by the tribe, the Tribal Historic Preservation Officer (THPO). In some cases, the THPOs have formally assumed the responsibilities of the SHPO on

their tribal lands. Whether or not the THPO has formally assumed SHPO responsibilities, they must be consulted when an undertaking occurs on tribal lands.

While the THPO must be consulted when a project occurs or affects historic properties on tribal lands, many historic properties of religious and cultural significance to Indian tribes are not located on tribal lands. Section 101(d)(6) of the NHPA states that properties of traditional religious and cultural importance to tribes can be eligible to the NRHP. This section goes on to require that agencies consult with any Indian tribe that attaches religious and cultural importance to such properties. This consultation requirement applies regardless of whether such properties are on or off tribal lands.

In accordance with Section 106 of the NHPA and the NAGPRA, Native American consultation would be conducted as part of NEPA compliance for future federally permitted projects.

2.6.4 Comparison to Previous Predictions

Predictions relative to potential future impacts to cultural resources were not presented in the Coal Development Status Check (BLM 1996) or earlier EISs (BLM 1979, 1981) for the Wyoming PRB.

2.7 Land Use

2.7.1 Key Issues

The key land use issues include:

- Compatibility of potential development activities with surrounding land uses;
- Potential for development activities to disrupt access to public lands;
- Potential adverse effects of development activities on recreation activities in the study region; and
- Potential for adverse effects on wilderness, potential wilderness, or wild and scenic river areas from development activities.

2.7.2 Study Area

The study area for land use includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (see **Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area (see **Figure 1-3**). A somewhat larger perimeter around this primary study area was considered for wilderness issues because of the greater sensitivity (both practical and statutory) that wilderness and potential wilderness areas embody.

2.7.3 Current Conditions

2.7.3.1 Land Use, Access, and Easements

Surface Ownership

The PRB is a predominantly rural, wide open landscape. Gillette is the largest city with 19,646 people according to the 2000 Census; Sheridan (15,804), Douglas (5,288), and Buffalo (3,900) followed in order of population, with no other community larger than 2,500 people. With little rainfall and limited alternative sources of water, the primary land use is grazing.

A substantial majority of the land surface in the basin is privately owned, perhaps showing a greater historical kinship with the Dakotas and Nebraska than with western Wyoming or other western states where federal lands predominate (see **Figure 1-3**). A total of 77.8 percent of the surface ownership in the study area is privately owned (**Table 2.7-1**). Approximately 14 percent is federal with the BLM managing approximately 11 percent and the USFS managing approximately 3 percent. The USFS land is in the TBNG, administered by the Medicine Bow – Routt National Forest. The State of Wyoming owns approximately 8 percent of the land in the study area, most of which is State Trust land provided to the state by the federal government at the time of statehood to support “common schools” (public schools) and a limited number of other public facilities. The Wyoming Office of State Lands and Investments administers state lands.

Table 2.7-1
Surface Ownership

Ownership	Acres	Percent
Federal		
BLM	873,438	11.0
USFS	254,592	3.2
State of Wyoming	628,702	7.9
Private	6,158,638	77.8
Total	**7,915,370**	**100.0**

Source: ENSR 2005b.

As shown in **Figure 1-3**, federal land in the study area does not occur in large, contiguous parcels. The TBNG is mainly in two clusters, one scattered through a 20-mile by 20-mile area in northeastern Campbell County and the second, a much larger cluster, in southeastern Campbell County and northeastern Converse County (also extending well into Weston County to the east). BLM surface lands also are primarily located in two areas, mostly in Johnson County. The first is in the southwest corner of the county. The second follows the main stem of the Powder River from a few miles north of Sussex to approximately the Sheridan County line where it diverts northeasterly toward Spotted Horse on U. S. Highway 14/16.

State lands generally include Sections 16 and 36 of almost every township, following a standard pattern for state trust lands in most of the west. In addition, there are larger blocks of state land located primarily in Johnson and Sheridan counties both north and south of Buffalo (see **Figure 1-3**).

Minerals Ownership

In contrast to the surface ownership, mineral rights in much of the study area are in "split-estates," meaning the surface owner is different from the owner of the mineral rights. In much of the study area, the surface is privately owned, but the mineral rights are at least partly federally owned. Although the federal government owns all mineral rights on large portions of the study area, there also are sizable areas where it owns only the coal rights and somewhat smaller areas where it owns only oil and gas rights. There are a few small areas where the federal government owns coal, and oil and gas rights, but no others; and where it owns other rights, but not coal or oil and gas. Other rights include locatable minerals, such as uranium and bentonite, and salable minerals, such as sand and gravel. Generally, where the USFS or the BLM manages the surface estate, the federal government also owns all of the mineral rights. The minerals ownership patterns generally are much more complex where the surface rights are privately owned.

The State of Wyoming typically owns the mineral rights for a majority of the state trust lands, although there also are areas where the federal government owns mineral rights on state lands.

There are areas scattered throughout the study area where the federal government owns no mineral rights. The largest of these is in western Sheridan County and northwest Johnson County from the Bighorn National Forest boundary eastward beyond I-90 and I-25. There is a similar large area in a broad swath along I-25 across Converse County and a smaller area along the eastern

boundary of Campbell County, approximately 10 miles east of Gillette. There are notable, though generally narrow, strips of land along several major creeks in the study area where the mineral estate is not owned by the federal government.

Where oil and gas rights are federally owned (see **Figure 2.7-1**) and the surface is privately owned, the gas developer is required to obtain an agreement with the surface owner regarding access to the property (43 CFR Part 3814). A surface use agreement may be required by the surface owner (BLM 2003a).

Surface use for coal and other minerals is somewhat more problematic, because the minerals in the PRB typically are recovered via surface mining, which eliminates pre-established or other non-mining use of the surface estate for the period from the beginning of active mining through completion of successful reclamation. Under these circumstances, the owner of the minerals must reach an agreement with the surface owner to compensate him/her for the productive value of the surface land for the duration of its use for mining. Leasing of federally owned coal may be delayed until an agreement is reached, although, generally the mineral resource in the PRB is much more valuable than the surface land to the degree that a coal developer is able to purchase the surface rights at a price that is attractive to the surface owner (Janssen 2004).

Existing Land Use Patterns

As noted above, climate and soil conditions in the study area dictate that the predominant use of land is grazing. Nevertheless, there is a range of productive and other land uses. The major categories include agriculture, forested, mixed rangeland, urban, water, wetlands, coal mines, and barren land. **Figure 2.7-2** illustrates generalized land use for the study area; **Table 2.7-2** shows approximate acreages for each of the land uses.

Agriculture. Agricultural land uses in the study area include cropland and pasture, confined feeding operations, and other agricultural uses. Most of the cropland is not irrigated; however, irrigated cropland occurs in limited areas, primarily adjacent to drainages. The four-county area generally is not highly productive for crops, although Campbell and Sheridan counties are in the top 10 Wyoming counties for production of oats, producing approximately 4 percent and 6 percent, respectively, of the state's total production in 2003 (U.S. Department of Agriculture [USDA] 2004). Barley, a small amount of silage corn, hay, and wheat also are produced in the study area.

Mixed Rangeland and Forest. Rangeland primarily is used for livestock grazing, which is the dominant land use in the study area on private and public lands. The primary use of the BLM- and USFS-administered forest lands within the study area also is grazing. Agricultural statistics for 2003 indicate that the four-county area supported approximately 20 percent of the cattle, 23 percent of the cows, and 19 percent of the sheep in Wyoming at the time the data were assembled (USDA 2004). The forested land category shown in **Figure 2.7-2** includes deciduous, evergreen, wetland/riparian, and mixed forest land.

Urban. Urban land uses in the study area include residential; industrial/commercial areas; and transportation, communications, and utility ROWs, as well as areas in transition from rural to more densely developed areas (**Figure 2.7-2**).

SHERIDAN COUNTY

CAMPBELL COUNTY

JOHNSON COUNTY

CONVERSE COUNTY

DAYTON

SHERIDAN

BUFFALO

GILLETTE

WRIGHT

KAYCEE

Legend

- Existing unreclaimed surface coal mine disturbance
- County boundary
- Perennial river or stream
- Railroad

Mineral Ownership

- Existing CBNG wells
- Federal
- Non-federal

WYOMING

N

W E

S

0 5 10 15 Miles

0 5 10 15 Kilometers

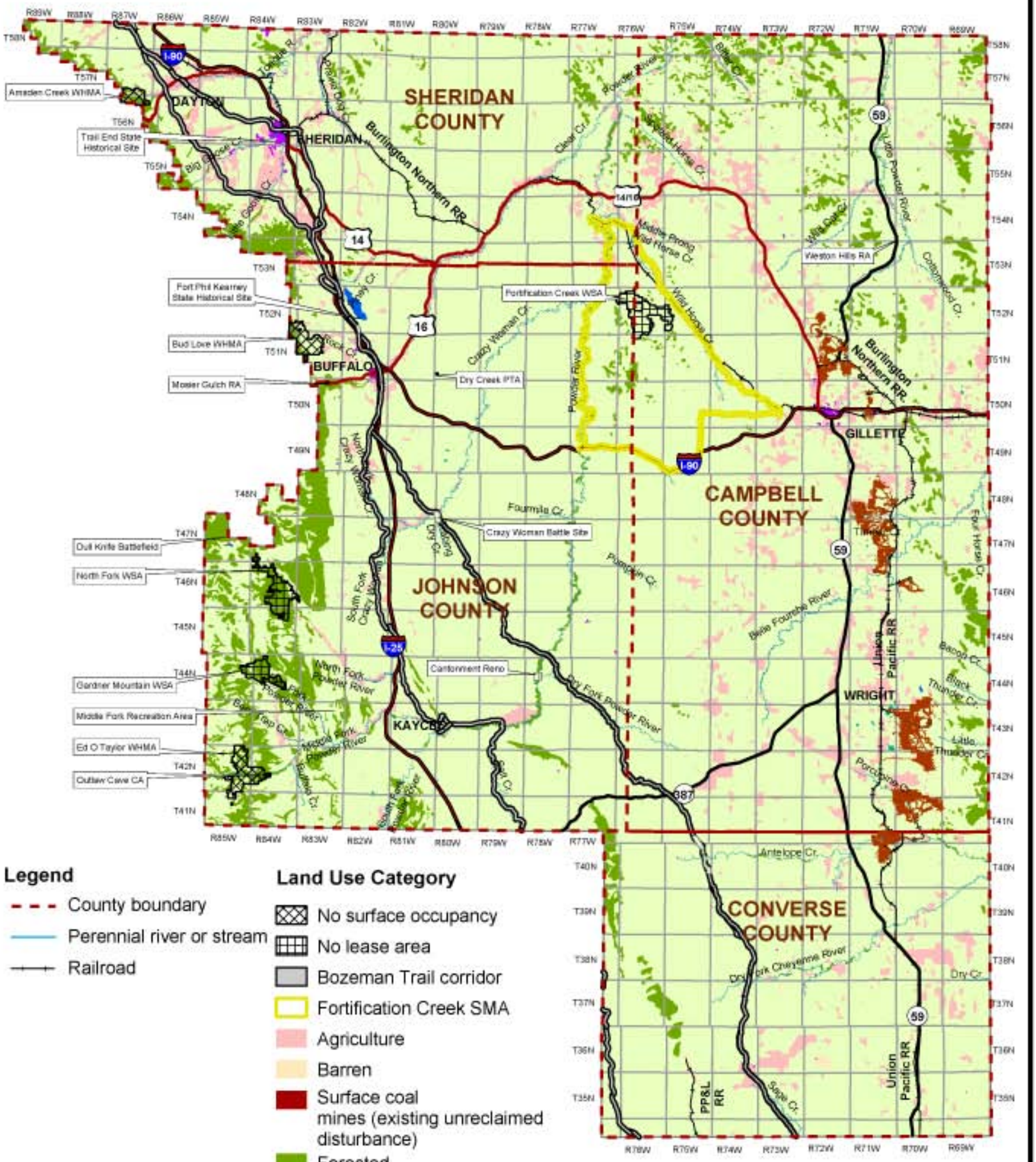
Source: BLM 2003a, 2004; IHS 2005; Thunder Basin Coal Company 2003; WOGCC 2005

Powder River Basin Coal Review

Figure 2.7-1

CBNG Mineral Ownership

6/20/05



Note:
CA = Cultural Area
GMU = Game Management Unit
PTA = Petrified Tree Area
WHMA = Wild Horse Management Area
WSA = Wilderness Study Area

Powder River Basin Coal Review

Figure 2.7-2

General Land Use and Recreation Sites

Source: BLM 2003a, 2004; Thunder Basin Coal Company 2003

Table 2.7-2
Land Use by Surface Ownership
(acres)

Use Category	BLM	USFS	State	Private	Total	
					Acres	Percent
Agriculture	2,627	14,197	13,770	472,811	503,405	6.3
Barren	165	205	187	9,396	9,953	0.1
Forested	137,555	14,604	48,645	332,062	532,866	6.7
Mixed Rangeland	732,014	218,156	561,363	5,271,644	6,783,177	86.0
Urban	893	17	1,039	25,469	27,418	0.3
Water	35	73	334	4,773	5,215	<0.1
Wetlands	0	104	559	1,566	2,229	<0.1
Coal Mines	149	7,236	2,805	40,917	51,107	0.6
Total	**873,438**	**254,592**	**628,702**	**6,158,638**	**7,915,370**	**100.0**

Note: Based on land use categories identified in **Figure 2.7-2**.
Source: ENSR 2005b.

Although rural residences are scattered throughout the study area, a substantial majority of the homes are located in or immediately adjacent to incorporated communities. Incorporated communities in the study area include Gillette and Wright in Campbell County; Douglas and Glenrock in Converse County; Buffalo and Kaycee in Johnson County; and Sheridan in Sheridan County. There also are numerous unincorporated communities in the study area. Although typically quite small, in the aggregate they account for a significant number of residences, and they tend to be primarily residential communities. Industrial and larger commercial areas, other than coal mines, generally are located in the larger, incorporated towns.

Water and Wetlands. The term water generally refers to open water areas. Wetland areas are regulated under the Clean Water Act. Section 2.3, Vegetation Including Wetlands and Riparian Areas, of this report and the Task 1 Report for the PRB Coal Review - Water Resources address wetland and water issues, respectively, in greater detail.

Coal Mines. Currently, there are 12 operating and 1 temporarily inactive coal mines in the Wyoming PRB. These mines are discussed in detail in the Task 2 Report for the PRB Coal Review – Past and Present and Reasonably Foreseeable Development. There also are historical mines in the study area that once produced coal, uranium, bentonite, and aggregate materials (sand and gravel). Federal coal lands considered to provide the greatest potential for development primarily are in the eastern part of the study area.

Barren Lands. Barren lands generally include dry salt flats, beaches, sandy areas other than beaches, bare exposed rock, quarries, gravel pits, and transitional areas. Barren lands may include active mines, other than coal, and historic mines.

Oil and Gas Development. As of the end of 2003, a total of approximately 14,758 CBNG wells and a total of 6,846 conventional oil and gas wells existed on federal, state, and private lands within the study area (ENSR 2005a). Existing CBNG wells and conventional oil or gas wells are discussed in greater detail in the Task 2 Report for the PRB Coal Review – Past and Present and Reasonably

Foreseeable Development. The wells and ancillary facilities resulted in approximately 49,042 acres of disturbance to existing land uses (ENSR 2005a).

Land Use Planning and Management

BLM Land Management. Lands administered by the BLM in the study area are managed under the guidance of the Resource Management Plans (RMPs) for the Buffalo and Casper field offices. Several BLM Special Management Areas that provide recreational opportunities are located within the study area. These areas include Wilderness Study Areas (WSAs) and other special areas that are addressed in further detail in Section 2.7.3.2, Recreation. Oil and gas leases are issued with no surface occupancy rights (for drilling, access routes, or production facilities) within WSAs in order to preserve the wilderness values. Surface disturbances also are restricted within recreational areas and wildlife habitat management areas. Wildlife habitat management areas are managed in cooperation with the WGFD. The BLM land use planning and management goals for these areas also are discussed below in Section 2.7.3.2, Recreation.

Because oil and gas resources frequently are located in the same vicinity as coal resources, oil and gas leases generally are issued with special stipulations to help prevent development conflicts with coal. These stipulations may require that a plan of mitigation of anticipated impacts be negotiated between the oil and gas and coal lessees before surface use. The current BLM oil and gas stipulation (BLM 2001a) prohibits or restricts surface occupancy or use within areas of conflict with ongoing coal mining. In addition to standard lease terms, special stipulations identifying specific terms and conditions of use may be attached to oil and gas leases, where needed, to protect specific natural resources.

Most of the BLM and USFS lands within the study area are used for livestock grazing under permitted grazing allotments. Livestock grazing is not permitted in certain areas to prevent conflicts with other uses, such as big game winter ranges and timber sale areas. Grazing allotments are classified by BLM into one of three management categories. These categories in order of priority are: maintain (M), improve (I), and custodial (C). Category M allotments are in satisfactory resource condition and are producing near their potential under existing management strategies. Improvements would produce an average economic return. Allotments in Category 1 generally are not producing at full potential, with opportunities to enhance or improve resource conditions at a high economic return. Category C allotments consist of relatively small acreages or parcels of public land interspersed with larger amounts of non-federally owned lands. They have little potential for multiple use management or positive economic returns. Most of the public land in the study area is in the M and I management categories.

BLM requires land use activities within allotment areas to comply with the specific standards and guidelines for healthy rangeland in cooperation with the State of Wyoming (BLM 1997a). Wyoming BLM Mitigation Guidelines (BLM 1995b) also are employed to avoid and mitigate impacts and conflicts among resources and land uses for surface-disturbing activities on BLM-administered lands in Wyoming.

USFS Land Management. The USFS administers land uses on National Forest System lands based on multiple use principles. The Douglas Ranger District of the Medicine Bow-Routt National Forest has responsibility for the public lands and activities within the TBNG, which makes up the bulk of National Forest land in the study area. Guidance is provided by the Land and Resource

Management Plan (LRMP) for the Medicine Bow National Forest and TBNG (USFS 2001a,b; 2002). The USFS completed an EIS and issued a record of decision (ROD) in 2002 for oil and gas leasing on the TBNG (USFS 2002). Numerous special leasing restrictions for oil and gas activities were included, addressing drilling or production activities within the TBNG.

The revised LRMP provides land use guidelines for 10 management areas within the TBNG, including one designated #8.4 Mineral Production and Development. This area encompasses 47,990 acres, or approximately 9 percent of the TBNG. It is to be "... managed with an emphasis on efficiently and effectively conducting mineral operations of all types, primarily coal, coal bed methane, oil, and gas" (USFS 2002).

Most of the USFS land in the study area is managed for livestock grazing. The USFS also has special stipulations to protect identified resources within USFS-administered lands.

Oil and gas leasing and development activities on USFS-administered federal lands within the TBNG are allowed, subject to the limitations imposed by the LRMP. Proposed actions must be in conformance with the management goals. Under the 1987 Federal Onshore Oil and Gas Leasing Reform Act, USFS lands that are available for oil and gas leasing were identified, along with the stipulations that are considered appropriate to protect surface resources.

Wyoming State Land Management. The State Land Use Planning Act (Wyoming Statute 9-849 through 9-862) was enacted by the Wyoming legislature in 1975; it established the State Land Use Commission to guide land use planning in the state. The Office of State Lands and Investments, the administrative and advisory arm of the Board of Land Commissioners and State Loan and Investment Board, is responsible for all leases, easements, and temporary uses on state lands.

The state-owned lands in the study area generally are available for mineral and agricultural leasing, timber leasing and sales, and public recreation. State Trust lands are lands granted by the federal government to the State of Wyoming to generate revenues for the benefit of designated beneficiaries. These beneficiaries are the common (public) schools, universities, and other public institutions in Wyoming (Wyoming Office of State Lands 1996).

The WOGCC regulates drilling and well spacing, and requires an approved application for permit to drill (APD) for all oil and gas wells drilled in the State of Wyoming regardless of land ownership, including wells on federal lands. The APD approval process includes securing the necessary legal access to or across state or privately owned lands.

Campbell County Land Use Planning and Regulation. The City of Gillette and the Town of Wright have zoning ordinances and land use plans for the incorporated areas. The City of Gillette/Campbell County Comprehensive Planning Program addresses potential future land use; important provisions are illustrated on the Campbell County Zoning District Map (City of Gillette and Campbell County Planning Commission 1994). Adjacent to and outside of the city limits of the City of Gillette, Campbell County has designated zoning districts, including numerous subdivisions and designated suburban and rural residential districts (Campbell County 2000a,b). The unincorporated areas of the county outside of the Gillette Planning District are considered to be Open District zoning or agricultural (BLM 2003a).

The City of Gillette zoning regulations (City of Gillette 1992) define oil, gas, and mineral exploration and production activities as permitted uses in agricultural or heavy industrial zoning districts. Oil and gas production activities require City Council permission and must meet the applicable provisions in the Gillette Municipal Code. Permits are required from the city for construction within the city limits, or use of existing rights-of-way (ROWs) and easements dedicated or owned by the city. City noise ordinances would apply to drilling or construction operations within city limits.

Similar permits and mitigation requirements are required in the Town of Wright's jurisdictional area (Town of Wright 1998).

Converse County. The Converse County Land Use Plan (Converse County 2003) describes the current land use in the study area as primarily agriculture, predominantly dryland (nonirrigated) grazing. Mineral extraction is the second prominent use for this portion of the county. Mineral extraction is exempted from local regulations by state law; however, mineral processing is regulated to minimize conflicts between mineral extraction and historic surface land uses. Converse County currently does not have countywide zoning. The city zoning ordinances for Douglas and Glenrock do have development requirements (BLM 2003a).

Johnson County. Johnson County promulgated a Draft Comprehensive Land Use Plan in June 2004 (Johnson County 2004). The communities of Buffalo and Kaycee have land use plans for their urban areas. The Buffalo/Johnson Joint Land Use Plan was adopted in August 2001; it will be superseded when the new Johnson County Plan is adopted. This plan primarily addresses land uses adjacent to the residential areas within 10 miles of Buffalo.

The Powder River Conservation District's Long Range Program Resource Conservation and Land Use Plan, adopted February 10, 1998, also provides land use guidance primarily to prevent erosion of soils for the southern half of Johnson County.

Sheridan County. Development in unincorporated portions of Sheridan County is regulated by the Sheridan County Zoning Resolution (Sheridan County 2001b), and the Sheridan County Growth Management Plan (2001a). With the exception of several designated growth areas near the existing residential developments, the anticipated future land uses and current zoning for most of the county is agricultural (BLM 2003a). Designated growth areas are defined for the areas in the immediate vicinity of the City of Sheridan, Town of Clearmont, and the unincorporated urban and residential communities of Story/Banner, Big Horn, Big Goose Valley, Ranchester/Dayton, and Arvada (Sheridan County 2001a). The City of Sheridan has designated zoning districts for its incorporated areas (Sheridan 2000).

The Growth Management Plan provides for a buffer zone of several miles adjacent to and east of the Bighorn National Forest, which is designated as a Resource Conservation Area on the Sheridan County Comprehensive Plan Land Use Map (Sheridan County 1999). In addition, a low-density development area is identified surrounding the City of Sheridan, including and extending south of the community of Big Horn. These planning areas currently are not addressed in the Sheridan County Zoning Resolution (Sheridan County 2001b).

2.7.3.2 Recreation

As noted above, the study area contains federal, state, and private lands. With nearly 80 percent of the area privately owned, public lands provide important open space and recreation resources including both developed recreation facilities and areas to pursue dispersed recreation activities. The private sector contributes the elements of commercial recreation opportunities and tourism services such as motels and restaurants. Some private land owners also allow hunting with specific permission, sometimes for a fee.

The study area offers broad, panoramic prairie landscapes, which provide a setting for a variety of outdoor recreational activities. Major attractions include the TBNG, several state historic sites, and the historic Bozeman Trail. Formal recreation opportunities are most prevalent in the western portion of the study area, near the foothills of the Big Horn Mountains, and in the Powder River Breaks.

Developed Recreation Facilities and Sites

Study area counties include several special recreation management areas on public and private lands. Recreation sites on public land are listed in **Table 2.7-3** and shown in **Figure 2.7-2**. Connor Battlefield State Historic Site and Trail End State Historic Site are in western Sheridan County, near the city of Sheridan. Fort Phil Kearney State Historic Site is in western Johnson County between the cities of Sheridan and Buffalo. Recreational activities available in the Connor Battlefield site include camping and fishing. The Trail End and Fort Phil Kearney sites feature museums and tours. Limited developed recreation facilities also are located in special management areas on BLM-administered public lands.

Two scenic byways provide access westerly from the study area into the Big Horn Mountains: the 47-mile-long Bighorn Scenic Byway on U.S. Highway 14 west of Ranchester, and the 64-mile-long Cloud Peak Skyway on U.S. Highway 16 west of Buffalo.

Bureau of Land Management. Several developed recreational sites and areas are located on BLM lands, all in the area administered by the Buffalo Field Office. The South Big Horns Area is located in the southwest quarter of Johnson County. The area provides sensitive and unique resource values, including fisheries, cultural, wildlife, wilderness, and scenery. Special management areas that provide recreational opportunities within the South Big Horns Area include the Middle Fork Recreation Area (RA), Red Wall/Hole-in-the-Wall area, Outlaw Cave Recreation Site (or Cultural Area), and Gardner Mountain and North Fork WSAs.

The Middle Fork RA covers 48,400 acres along the Middle Fork of the Powder River. The area contains a variety of outstanding natural resources and is protected from mineral entry because it has unique visual qualities, wildlife habitat, fisheries, and general outdoor recreation qualities. The State of Wyoming has rated the Middle Fork of the Powder River as a Class I trout fishery that is of national importance. The Outlaw Cave Recreation Site, located in the Middle Fork RA, is an important historical site that provides camping, fishing, hiking, and other dispersed recreational activities.

Table 2.7-3
Recreation Sites by Management Agency

Managing Agency	Recreation Sites
Federal	
BLM	Middle Fork RA
	Ed O. Taylor Wildlife Habitat Management Area
	Gardner Mountain WSA
	North Fork WSA
	Outlaw Cave Recreation Site
	Fortification Creek SMA and WSA
	Cantonment Reno
	Dry Creek Petrified Tree Environmental Education Area
	Mosier Gulch RA
	Weston Hills RA
	Crazy Woman Battlefield
USFS	TBNG
State	
WGFD	Amsden Creek WHMA
	Bud Love WHMA
WSPHS[1]	Connor Battlefield
	Trail End State Historical Site
	Fort Reno
	Fort Phil Kearny State Historical Site
None	
--	Bozeman Trail
--	Dull Knife Battlefield

[1]WSPHS = Wyoming Division of State Parks and Historic Sites
WYDOT = Wyoming Department of Transportation

Source: BLM 2003a.

The Dry Creek Petrified Tree Environmental Education Area, located near the town of Buffalo, has been designated as an outstanding natural area. The area provides a picnic table and interpretive facilities.

Three WSAs provide primitive, undeveloped types of recreation (see **Figure 2.7-2**). There is no public access to the North Fork or Fortification Creek WSAs. Public access to the Gardner Mountain WSA is difficult because of the scattered land ownership.

The Mosier Gulch RA is located west of Buffalo on U.S. Highway 16. It includes a picnic area and provides off-highway vehicle use on designated roads and a loop trail open to foot, horse, mountain bike, and all-terrain vehicle use. The Weston Hills Recreation Area is located in the eastern part of the study area, adjacent to a portion of the TBNG. It provides hunting and dispersed camping recreational opportunities.

Burnt Hollow, approximately 25 miles north of Gillette, is currently a dispersed, non-motorized recreation SMA, but it has received some development attention with parking facilities, and there are long-term plans to develop it further.

The Bozeman Trail is a historic transportation corridor that was used by Indian tribes, trappers and traders, exploration expeditions, American emigrants, the military, and settlers. The trail originates near Fort Laramie, south of the study area, and runs northwesterly through the study area along the eastern side of the Big Horn Mountains into Montana (see **Figure 2.7-2**). Much of the actual trail is on private land and is not generally accessible to the public. Historic sites associated with the trail provide recreational opportunities through interpretive programs at Fort Phil Kearny, Cantonment Reno, Fort Reno, the Connor Battlefield, and the Crazy Woman Battlefield, which recently has been upgraded with better access and interpretive monuments and signs.

U.S. Forest Service. The TBNG provides a variety of wildland recreational opportunities to local residents and visitors. Nearly all of the TBNG is open to ORV use. The area provides hunting opportunities for residents and non-residents, primarily for big game species such as antelope and deer. Shooting restrictions recently have been implemented to protect the special biological community associated with the future reintroduction of the endangered black-footed ferret.

Dispersed Recreation Opportunities

Accessible public lands managed by BLM's Buffalo and Casper field offices provide diverse opportunities for recreation, including hunting, fishing, ORV use, sightseeing, and wildlife observation. Public lands generally provide dispersed recreational uses in the study area. Some developed recreational facilities occur in special management areas, including recreation areas. While opportunities are available on BLM lands throughout the study area, the majority of dispersed recreational uses occur in the western part of the study area, including the South Big Horns Area and along the Powder River. Public lands elsewhere consist mainly of isolated tracts of land that are too small to provide a quality recreational experience. Larger parcels of public lands occur in the southwest part of Johnson County and along the Powder River. Public lands are accessible via public roads or across private land with the landowner's permission.

The WGFD manages big game populations in big game management units. All or part of 18 antelope units, 22 deer (white-tail and mule) units, and 9 elk units are located in the study area. A majority of the antelope and deer hunting that occurs in the area is by non-resident hunters. Mule deer and pronghorn hunting are by far the most popular hunting activities in the study area, accounting for 35,529 and 21,304 hunter days, respectively, in 2003 (Stratham 2005). The next highest were cottontail rabbit (2,348 hunter days) and elk (2,055 hunter days), followed by wild turkey (1,019), sharp-tailed grouse (508), and sage grouse (38). Consistent trends in hunter activity over the past decade are not discernible from the WDFG data. All of the most prominent species hunted in the study area have had high years and low years; pronghorn hunting, for example, was greatest from 1993 to 1996 while elk hunting was a its peak in 2001 and 2002. Mule deer hunting has been the most consistent ranging from a low of 28,311 hunter days in 1996 to a high of 37,307 hunter days in 2002.

ORV use in the study area is available on most BLM-managed lands. Most of the public land in Johnson, Sheridan, and Campbell counties has been inventoried and designated as open, limited, or closed to ORV use. Approximately 20,386 acres are open to unlimited vehicle travel on and off roads. There are 4,680 acres in the area that are closed to all ORV use and approximately 867,534 acres available for limited use. Limited use typically means ORVs are restricted to existing roads and vehicle routes.

Recreational use of public lands in the study area has increased substantially over the past two decades, and is expected to continue to increase by about 5 percent every 5 years for most recreational activities (BLM 2003a). Total visitor use by residents and nonresident visitors in Campbell and Converse counties in 1980 was projected at 1,276,000 visitor days (BLM 1979). The total visitor days of 1,881,763 estimated for 1990 was approximately 47 percent higher than the 1980 visitor days (BLM 2001a). Fewer than 3 percent of visitor days were estimated to occur on public lands.

Fishing is a popular year-round activity for residents of the study area. Bodies of water that are fished within the study area are summarized **Table 2.7-4**.

Table 2.7-4
Popular Fishing Areas

Water Body	Fish Species
Beartrap Creek	Brook and rainbow trout
Blue Creek	Brown, brook, and rainbow trout
Dull Knife Reservoir	Brown and rainbow Trout
Powder River, Middle Fork	Brown trout
Powder River, North Fork	Brown and rainbow trout
Crazy Woman Creek	Brown, brook, and rainbow trout
Doyle Creek	Brown and brook trout
Clear Creek	Brown and rainbow trout
Lake De Smet	Brown and rainbow trout
North Piney Creek	Brook and rainbow trout
Gillette Lake	Rainbow trout

Some private landowners in the study area receive supplemental income from providing hunting and fishing opportunities. In 2001, following evaluation as a trial project, the Walk-in Area (WIA) was implemented as a permanent program by the WGFD. The WIA program allows the WGFD to assist landowners who support wildlife and maintain public hunting and fishing opportunities. The WGFD leases hunting rights on private land tracts. Participating landowners receive monetary compensation based on the size of the tract of land enrolled in the program.

The WGFD has observed a trend toward a reduction in private land available for public hunting in recent years (Shorma 2005). Although no quantitative analysis has been conducted to date, the decline has been noted in the numbers of deer and pronghorn licenses unsold. WDFG attributes much of the change to the dramatic expansion in CBNG development in the PRB (Shorma 2005; Jahnke 2005). Several factors may be involved including the spacing of CBNG wells and the associated network of roads and support facilities that create both real and perceived safety problems, especially for rifle hunters; mineral royalties and surface reclamation reimbursements

reduce a landowner's need for revenue from hunting; and the activity levels associated with CBNG development may displace wildlife from their traditional ranges (Shorma 2005). The problem is exacerbated by a parallel trend for some landowners to lease exclusive hunting rights to an outfitter or a small group of individual hunters, which further reduces the land available to the general public (Jahnke 2005). Coal development is not considered to be a major factor in reduced hunting access, because it is much more localized with disturbed acreage concentrated in just a few areas (Jahnke 2005). Reclaimed mine land may or may not be available for hunting and other recreational activities depending on site-specific constraints.

CBNG development also has had the effect of degrading the hunting experience for those who do hunt in the PRB. The spreading network of CBNG facilities has degraded the aesthetics of the open space; noise, traffic, and dust from CBNG development activity have generated a number of unsolicited adverse comments from hunters in the WDFG's hunter harvest surveys (Jahnke 2005). The loss of hunting land also has created problems for the WDFG by making herd management more difficult and by reducing revenues from hunting (Shorma 2005). While the total numbers of hunters have not significantly declined, the reduced access to private land has substantially increased pressure on public lands and has tended to concentrate hunting activity, which further degrades the experience for hunters (Jahnke 2005).

Recreation Planning

Bureau of Land Management. The goals of recreation management for all BLM-administered lands in the study area are to provide outdoor recreational opportunities while also protecting resources, providing visitor services, and protecting the health and safety of public land visitors.

The BLM has developed a management objective for special management areas within the study area, including the South Big Horns Area, the Dry Creek Petrified Tree Environmental Education Area, the Fortification Creek Area, the Weston Hill RA, and the Mosier Gulch RA. The management objective for recreation in these areas is to ensure continued public use and enjoyment of recreation activities while protecting and enhancing natural and cultural values; to improve opportunities for high-quality outdoor recreation; and to improve visitor services related to safety, information, interpretation, and facility development and maintenance.

Additional details on recreation objectives and standards for BLM lands in the study area can be found in the Buffalo and Casper field office RMPs (BLM 1997b, 2001).

U.S. Forest Service. The Medicine Bow-Routt National Forest has developed an LRMP for the TBNG (USFS 2001a). Under the preferred Alternative 3, which was designated for implementation in the ROD, TBNG lands in the study area are included in 10 management areas. Each management area is managed for a particular emphasis or theme.

National Forest System lands are inventoried and mapped by Recreation Opportunity Spectrum (ROS) class to identify the opportunities for recreation activities that occur on these lands. The ROS system is a continuum divided into eight classes ranging from Primitive to Urban. Six of the classes have been identified in an inventory of TBNG lands: Urban (8.7 percent), Rural (7.5 percent), Roaded Natural (75.8 percent), Roaded Natural Non-motorized (2.8 percent), Semi-primitive Motorized (4.0 percent), and Semi-primitive Non-motorized (1.2 percent). Roaded natural, the

dominant classification on the TBNG, is "… characterized by predominately natural-appearing environments with moderate evidence of the sights and sounds of people. Such evidence is usually harmonious with the natural environment. Interaction between users may be moderate to high, with evidence of other users prevalent. Resource modification and utilization practices are evident but compatible with the natural environment. Conventional motorized use is allowed and incorporated into construction standards and design of facilities" (USFS 2001a). For a more complete discussion on ROS classes refer to Chapter 4 of the USFS ROS Book (USFS 1986).

State of Wyoming. The mission of WSPHS is to provide quality recreational and cultural land and opportunities, and to be responsible stewards of these resources. The Wyoming Department of State Parks and Cultural Resources has the authority to promulgate rules and regulations governing state parks. These rules include and cover the following areas: 1) conservation of peace and good order within each park; 2) preservation of state property; and 3) promotion of well being for park visitors and residents. There is no provision in the rules and regulations governing the development of mineral or other industrial developments within state parks.

Sheridan County. Sheridan County has adopted its Growth Management Plan, a comprehensive master plan for the City of Sheridan and all of Sheridan County (2001a). One of the primary themes identified in the Sheridan Plan is to maintain a community character that preserves the quality of life, values, and traditions of the area. The plan places a high emphasis on enhancing recreation opportunities and preserving open space in the city and county.

Campbell County. The City of Gillette and Campbell County have a joint Comprehensive Planning Program, last updated in March 1994. The program identifies parks and recreation planning as an essential element determining the character and quality of the environment of the city and county (City of Gillette and Campbell County 1994).

Converse County. The General Land Use Plan for Converse County was developed in 1978 and updated in 2003. According to the original plan, Objective #3 for Rural Centers was to provide for recreational activities as required to accommodate an increase in population. The policy to achieve this objective is to have recreational developments only in those areas with adequate access and in conformance with the Land Use Plan and Converse County Subdivision and Development Regulations. No substantive change was made to the plan relative to recreation in the 2003 update (Musselman 2004).

Johnson County. Johnson County promulgated a Comprehensive Land Use Plan in June 2004 (Johnson County 2004). The plan documents locations of existing recreation facilities in Johnson County, reports a BLM forecast of growing demand for recreational activities in the PRB, encourages participation by the county in recreation planning by the USFS and BLM for public lands, and encourages conservation of aquatic and wildlife resources in the county. The plan also encourages expansion of WGFD efforts to lease private lands for public hunting and fishing.

2.7.3.3 Wilderness and Roadless Areas

There are no designated wilderness areas in the study area. The nearest designated area is the 192,000-acre Cloud Peak Wilderness along the ridge of the Big Horn Mountains. At its nearest point, Cloud Peak is less than 4 miles west of the nearest point on the study area boundary. There also is a much smaller, 10,000-acre Black Elk Wilderness approximately 90 miles east of the study area.

There are three BLM WSAs in the study area (see **Figure 2.7-2**). The largest is the Fortification Creek WSA, located on the Campbell-Johnson County line, just south of the Sheridan County line. The two smaller ones are located in west-central Johnson County; they are identified as the North Fork WSA and the Gardner Mountain WSA. The WSAs await Congressional action before they can be designated or released from consideration. WSAs are managed as if they were designated in order to protect the identified wilderness values in the event of a future wilderness designation.

There is a USFS "inventoried roadless" area within the TBNG, which is essentially the USFS equivalent of a BLM WSA. In the inventory process, the area in the TBNG was not recommended for wilderness designation; however, as with the WSAs, it remains somewhat in limbo until and unless Congress acts on it.

2.7.3.4 Wild and Scenic Rivers

The BLM has identified public lands along four waterway segments in the study area that were determined to meet the eligibility criteria for Wild and Scenic River (WSR) designation. The waterway review segments that were evaluated for eligibility criteria are along Beartrap Creek, the Middle Fork of the Powder River, Powder River at Cantonment Reno, and the North Fork of the Powder River. The Beartrap Creek, North Fork of the Powder River, and the Powder River at Cantonment Reno review segments were found to be not suitable for WSR status primarily because of adjacent private land use and public access conflicts, or because they would not be worthy additions to the system. The Middle Fork of the Powder River was determined to be a worthy addition to the WSR system. The eligibility analyses for the four waterway review segments are included in attachments A, B, and C of BLM's approved RMP for the Buffalo Field Office (BLM 2001b). The analysis for the Middle Fork of the Powder River identified "outstandingly remarkable values" including: scenic, fisheries, wildlife, recreational, historic, cultural, spectacular, and primitive canyon. Specifically, these include the nationally and regionally historic Outlaw Cave, Native American rock art and shelter sites, a Class 1 fishery, recreational hiking, and cultural interpretation opportunities.

2.7.4 Comparison to Previous Predictions

2.7.4.1 Land Use, Access, and Easements

Projections of land use change, or disturbance, from 1979 and 1981 (BLM 1979, 1981, 1996) did not follow a consistent pattern (see BLM 1996, Table 2). In particular, the 1979 Eastern Powder River Coal Final EIS (BLM 1979) quantified acres of disturbance for several categories that were not specified in the Powder River Regional Coal Final EIS (BLM 1981), including railroads; oil and

gas development; and mining for uranium, sand, gravel, and scoria. Several of these categories have seen substantial increases in acreages of disturbance since the early projections were made.

There also were some unexplained inconsistencies within the 1981 document. The projected disturbance for "vegetation types and land use" (BLM 1981, Table 4-3, Alt. 3) adds up to 64,200 acres, whereas the disturbance for "wildlife habitat" (BLM 1981, Table 4-4, Alt. 3) adds up to 217,414 acres, over three times as much.

Recognizing these anomalies, the previous Coal Development Status Check (BLM 1996) indicated coal mining operations and facilities had disturbed 31,797 acres by 1990 and 41,064 acres by 1994. These levels were substantially larger than the 22,794 acres projected in 1979, but less than the 48,400 acres projected in 1981 for these activities. (Although the 1981 figure apparently included Montana acreage, whereas the 1979 figure did not [BLM 1996].) As of the end of 2003, the total existing disturbance from coal mine operations and facilities totaled approximately 51,107 acres (ENSR 2005b), and the total reclaimed area included 21,238 acres (ENSR 2005a).

Several other categories illustrate notable differences in disturbance acreages compared to the 1979 projections. Railroad disturbance in 1990 and 1994 was over 2.6 times higher than projected, but much of the difference is due to inclusion of pre-existing mainline rights-of-way in tabulations for the later years. Oil and gas development, including CBNG, was almost double the 5,250 acres of projected disturbance in 1990 and 1994. As of the end of year 2003, it was approximately 49,042 acres (ENSR 2005a). Disturbance from mining of other minerals is substantially lower than was projected in 1979. The 1994 disturbance (4,587 acres) was only 20 percent of the 1979 projection. The 2002 disturbance was approximately 5,600 acres (BLM 2003a). Due to the lack of information relative to specific locations for these smaller mining operations and the low overall disturbance acreage, which per subwatershed would be minimal, the associated disturbance area was not re-evaluated for this study. Finally, disturbance from population-related development is estimated at less than one-third of what was projected in 1979. This is due to substantially lower growth in PRB population than was projected.

The projections of disturbance acreage were not identified relative to specific land uses and have not been tracked to that level of specificity. It can be assumed that a substantial majority of the disturbance has been to rangeland, but the changes have not been quantified.

2.7.4.2 Recreation

Projections of recreation use were primarily in visitor days for a variety of recreation activities. Total visitor use by residents and nonresident visitors in 1980 was estimated at 1,276,000 visitor days. A total of 1,991,000 visitor days was predicted for 1990, but the actual use was estimated at 1,881,763 visitor days, about 5 percent lower than predicted (BLM 1979, 2003a).

There have been substantial improvements and increases in recreational facilities, particularly in developed areas like Gillette. Much of the use of these urban park and recreation facilities is likely over and above the visitor day estimates.

2.7.4.3 Wilderness and Roadless Areas

Changes in wilderness and roadless areas were not projected in 1979 or 1981. Some increase in wilderness hiking recreation was forecast; however, it was not specifically quantified for wilderness or roadless areas. Therefore, there is no basis for a current status check.

2.8 Noise and Visual Resources

2.8.1 Key Issues

The key issues related to noise and visual resources in the PRB include:

- Potential for noise from development to adversely affect residences, campgrounds, or other noise-sensitive receptors (land uses) in the study area; and

- Potential for development to be visually intrusive to a greater degree than would be acceptable under the BLM Visual Resource Management (VRM) System or the USFS Scenery Management System (SMS).

Potential noise-related effects to wildlife are discussed in Section 2.4 of this report.

2.8.2 Study Area

The baseline study area for noise and visual resources includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (see **Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS (see **Figure 1-2**). State and private lands also are included in the study area (see **Figure 1-3**).

2.8.3 Current Conditions

2.8.3.1 Noise

Noise generally is defined as unwanted sound. The effects of noise on people range from annoyance and inconvenience to temporary or permanent hearing loss. Since the human ear is not equally sensitive to sound at all frequencies, a frequency-dependent scale was developed so that full spectrum noise measurements could be adjusted to represent noise as it is perceived by human hearing. Sound intensity is measured in decibels (dB). The dBA compensates for the sensitivity of the human ear by discriminating against frequencies at the upper and, especially, the lower ranges of the audible sound spectrum. The dBA has been selected by most authorities for purposes of environmental noise regulation.

The decibel scale used for noise measurement is a logarithmic scale. Differences in noise levels must be calculated with this in mind. For example, combining sound from two sources producing 50 dBA each results in a total level of 53 dBA, not 100 dBA. A 10 dBA change in noise level represents a doubling in the energy level and is perceived by most people as a doubling of sound level. An increase from 40 dBA to 50 dBA would be twice as loud; an increase from 40 dBA to 60 dBA would be four times as loud, and so forth. The smallest perceivable change in noise levels is typically 3 dBA; an increase of 5 dBA is more clearly noticeable by the human ear.

Ambient, or background noise, is the all-encompassing noise associated with a given environment, usually a composite of sounds from many near and far sources. Outdoors, average nighttime

ambient noise is, in general, lower than daytime ambient levels by approximately 5 dB. This difference, however, is widely affected by the characteristics of the area and environment. Ambient noise usually is most critical at nighttime during the summer, when people are resting, windows are often left open, and traffic or other noise generating activities are usually at a minimum.

Typical sounds in most communities range from 40 dBA (very quiet) to 100 dBA (very loud) or higher. Conversation is roughly 60 dBA at 3 to 5 feet. As background noise levels exceed 60 dBA, speech intelligibility becomes increasingly difficult. Noise generally becomes physically uncomfortable at 110 dBA. The above sound levels are stated in terms of short-term maximum sound. Some commonly experienced noise levels are illustrated in **Table 2.8-1**.

Table 2.8-1
Typical Sound Levels of Common Noise Sources

Sound Pressure Level (dBA)	Common Indoor Noise Levels	Common Outdoor Noise Levels
110	Rock band	--
105	--	Jet flyover at 1,000 feet
100	Inside New York subway train	--
95	--	Gas lawn mower at 3 feet
90	Food blender at 3 feet	--
80	Garbage disposal at 3 feet, or shouting at 3 feet	Noisy urban daytime
70	Vacuum cleaner at 10 feet	Gas lawn mower at 100 feet
65	Normal speech at 3 feet	Commercial area, heavy traffic at 300 feet
60	Large business office	--
50	Dishwasher in next room	Quiet urban daytime
40	Small theater, large conference room	Quiet urban nighttime
35	--	Quiet suburban nighttime
33	Library	--
28	Bedroom at night	--
25	Concert hall (background)	Quiet rural nighttime
15	Broadcast and recording studio	--
5	Threshold of hearing	--

Source: BLM 2002a.

Ambient noise generally is a function of land use and density, although other environmental factors also may play a substantial role. Wind, precipitation, wildlife, and insects substantially can increase ambient noise in many places. Residents of the PRB study area are likely well familiar with these environmental influences.

Land uses in the PRB study area range from sparsely populated rural ranching areas to more densely populated urbanized areas and industrial areas such as coal mining and CBNG operations. Major sources of noise are larger towns; industrial facilities (e.g., coal mines and gas compressor stations); and major transportation facilities, particularly higher volume roadways such as I-90, I-25, and SR 59 near larger communities and railroad corridors. Frequent high winds raise noise levels well above ambient levels without wind.

Background noise surveys have not been conducted in the study area; however, noise in rural areas away from industrial facilities and transportation corridors is likely to be in the range of 30 to 40 dBA when the wind speeds are low. Levels of noise close to industrial facilities and transportation corridors are likely to be in the range of 50 to 70 dBA or more, depending on the source and proximity to the source. The most substantial noise from CBNG operations results from the operation of compressor stations that use multiple engines to move natural gas from central gathering facilities and along high-pressure transmission pipelines. Noise from these compressor stations has been estimated to be 55 dBA at 600 feet from the compressor station (BLM 2000b).

The potential effects of noise depend on the spatial relationship between a noise source and noise-sensitive receptors. Noise attenuates over distance; the rate of attenuation also depends on the nature of the ground surface, atmospheric conditions, and topography, which can either block or reflect noise transmission. Consequently, effects of noise generally are site-specific, and generalizations over an area as large and diverse as the PRB study area may be misleading if not carefully qualified.

2.8.3.2 Visual Resources

Regional Landscape Character

The PRB study area is isolated in the Great Plains physiographic province; it is bordered by the Big Horn mountains to the west and the Black Hills to the east.

The landscape is composed of open grasslands, low rolling hills, and unobstructed views over many miles in most places. Most of the area is covered with dryland vegetation consisting of grasses and shrubs. Ponderosa pine forest covers large portions of the northeast quarter of the study area. Outside the urban centers of Sheridan, Gillette, Buffalo, and Douglas, the PRB study area is characterized by a rural landscape that has been modified by oil and gas field development, coal mines, grazing, and small towns. Grazing is evident in most of the area. Highways, county roads, private roads, and utility lines also are evident throughout the area. Portions of the study area remain natural and undeveloped in character despite widespread mineral development and grazing.

The most significant scenic values occur in the western portion of the study area. The South Big Horn Area, located in the southwest quarter of Johnson County primarily along the Middle Fork of the Powder River, provides sensitive and unique resource values, including scenery. Special management areas (SMAs) within the South Big Horn Area include the Middle Fork RA, the Red Wall/Hole-in-the-Wall area, Outlaw Cave, Dull Knife Battlefield site, and the Gardner Mountain and North Fork WSAs. The Powder River breaks in eastern Johnson County, the Fortification Creek SMA and WSA, and the Weston Hills RA in the eastern part of the study area also provide scenic settings for a variety of dispersed recreational activities.

Two scenic byways in the western part of the study area provide access to the Big Horn Mountains. The Bighorn Scenic Byway is on U.S. Highway 14 west of Ranchester. The Cloud Peak Skyway is on U.S Highway 16 west of Buffalo.

Oil and gas pumping units and associated well pads and access roads are evident in much of the study area. A majority of existing wells and facilities are in the eastern half of the study area in

40- and 80-acre well spacing patterns. Well development is most evident in Campbell County between the cities of Gillette and Wright, and north, west, and northwest of Gillette. Development also is evident along I-90, and U.S. Highways 14 and 16 in Campbell and Sheridan counties. The landscape that has resulted from ongoing oil and gas development in this area is rural/industrial in character. The wells are intrusive (defined as readily visible) and visually dominant in the foreground (0.25- to 0.5-mile from the observer) views from roads and trails. In middleground (generally 0.5 mile to 3 miles) and background (more than 3 miles) distance zones, well pads and associated access road clearings are the most obvious feature of oil and gas development. Clearings are visible as light brownish gray exposed soils in geometric shapes with straight, linear edges that provide textural and color contrasts with the surrounding undisturbed vegetation. In general, oil and gas facilities are visually subordinate to the landscape in middle to background distance zones.

For natural gas development, the most prominent visual features, other than well pads, are the large compressor stations that transport the collected gas into and through the major pipelines. Although colors usually are selected to blend with the surroundings, the scale and character of the structures is often larger and appears more industrial than the agricultural landscape and facilities common to the area. Oil development, on the other hand, generally entails use of pumping “mules” on each well and tanks to store the oil awaiting shipment. Though typically smaller than the compressor stations, these facilities are more widely dispersed in the landscape and sometimes exhibit greater color contrast.

Coal mining occurs primarily in the east-central part of the PRB study area, east and south of Gillette. Twelve open-pit coal mines are actively producing coal in Campbell County; one coal mine in Campbell County is temporarily inactive. Open-pit mining results in landscapes that have been altered considerably from the natural character of the landscape. The topography of the landform is modified; there are significant color contrasts from exposed soils and spoil piles; vegetation is removed until post-mining reclamation occurs; dust is generated from mining operations; and associated infrastructure such as buildings, rail spurs, and road systems are introduced into the landscape that previously appeared relatively natural. Coal mines dominate foreground and middleground views in the affected viewsheds; background views generally depend on the status of reclamation activities and the perspective from a particular viewpoint. Coal mines commonly result in greatly disturbed landscapes that require rehabilitation through required reclamation activity after mining (see “Class V” in **Table 2.8-2** under VRM below).

Visual Resource Management

Bureau of Land Management. The BLM is responsible for identifying and protecting scenic values on public lands under several provisions of the Federal Land Policy and Management Act of 1976 and NEPA. The BLM VRM system was developed to facilitate the effective discharge of that responsibility in a systematic, interdisciplinary manner. The VRM system includes an inventory process, based on a matrix of scenic quality, viewer sensitivity to visual change, and viewing distances, which leads to classification of public lands and assignment of visual management objectives. Five VRM classes have been established, which serve two purposes: 1) as an inventory tool portraying the relative value of existing visual resources, and 2) as a management tool portraying visual management objectives for the respective classified lands. (Class V requires selection of a different class as the management objective.) The management objectives for each of

the VRM classes are displayed in **Table 2.8-2**. The system also includes a contrast rating procedure for evaluating the potential visual effects of a proposed project or management activity.

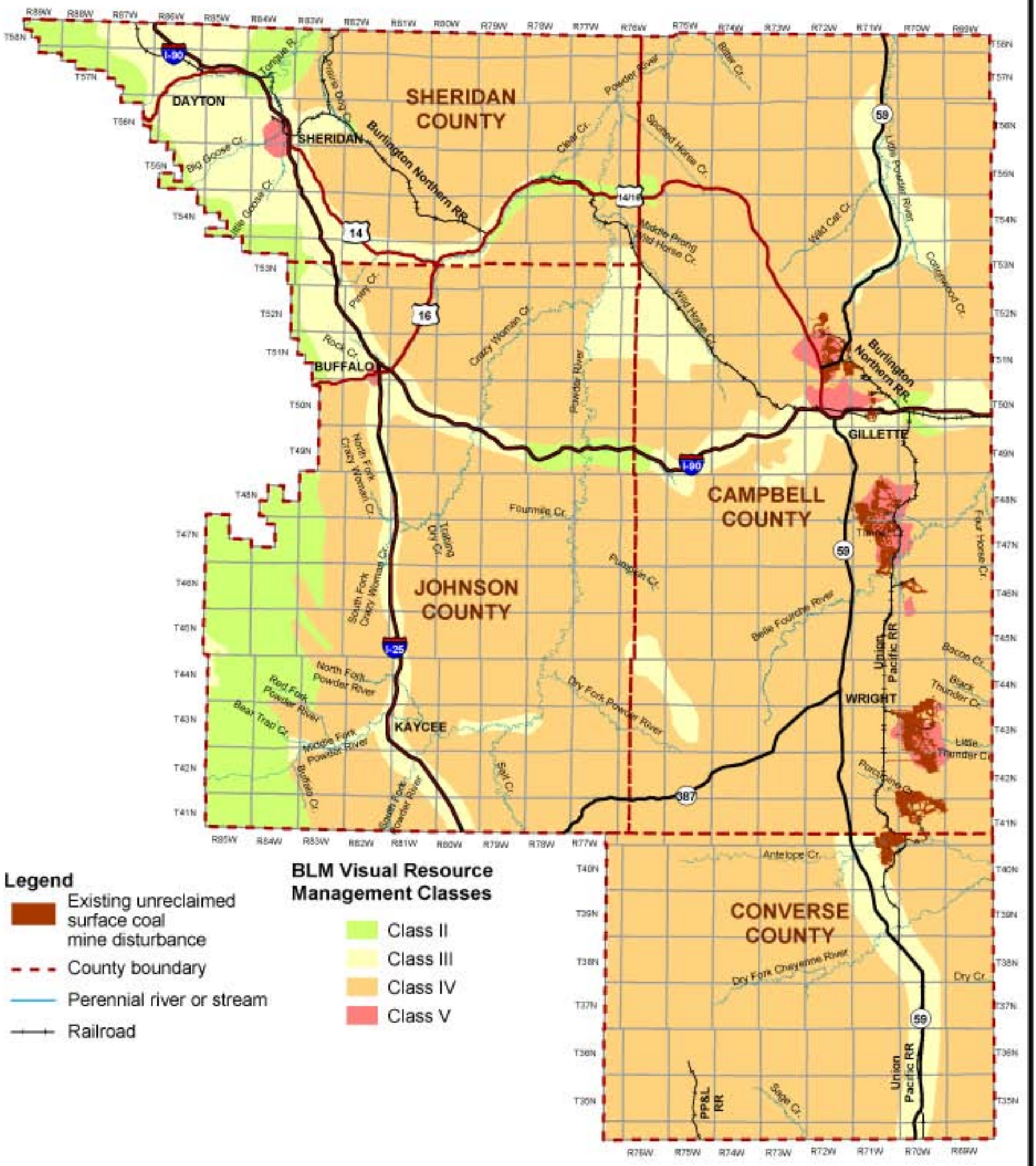
Table 2.8-2
BLM Visual Resource Management Class Objectives

Class	Description
Class I Objective	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention. (Class I is limited to application in wilderness areas, wild and scenic rivers, and similar situations.)
Class II Objective	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic (design) elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III Objective	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV Objective	The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.
Class V Rehabilitation Areas	Areas in need of rehabilitation from a visual standpoint should be flagged during the inventory process. The level of rehabilitation will be determined through the resource management planning process by assigning the VRM class approved for that particular area.

Source: BLM 1986a.

The BLM has inventoried visual resources and established VRM classes for all BLM, state, and private land in the study area according to the VRM system. The inventory includes state, USFS, and private lands as well as BLM-administered lands; however, the BLM has the authority and responsibility to manage visual resources only on BLM-administered lands. Many private and public lands in the area have increased in sensitivity since the last inventory conducted in the 1970s as a result of increases in population and lifestyle shifts that emphasize outdoor recreation. Four VRM classes have been identified in the study area. **Figure 2.8-1** shows the generalized pattern of VRM classes for the study area.

As **Figure 2.8-1** illustrates, Class IV is the predominant VRM class, encompassing approximately 78 percent of the study area. Class III follows with approximately 14 percent. Class II applies to approximately 8 percent of the area. Generally speaking, the Class III areas reflect greater sensitivity along major highway corridors, and the major Class II areas reflect somewhat higher scenic quality, particularly along the foothills of the Big Horn Mountains. Class V (Rehabilitation)



Source: BLM 2003a, 2004; Thunder Basin Coal Company

Powder River Basin Coal Review

Figure 2.8-1

BLM Visual Resource Management Classes

6/20/05

areas were applied primarily to active coal mines and to certain areas around several of the larger communities in the study area. Class V is applied to approximately 1 percent of the study area.

U.S. Forest Service. The Medicine Bow-Routt National Forest has developed a Revised Land and RMP for the TBNG (USFS 2001a). The USFS has inventoried visual resources under the new SMS, which incorporates viewing distance zones, concern level (public importance), scenic attractiveness (indicator of intrinsic scenic beauty of a landscape), scenic class (determined by combining the scenic attractiveness with distance zone and concern levels), and existing scenic integrity (state of naturalness).

Scenic Integrity Objectives (SIO) were assigned to each management area based on the intent of the management area direction. SIOs provide goals for management of grassland and forest scenic resources. There are five SIOs ranging from Very Low to Very High, plus an inventory class ("unacceptably low") (see **Table 2.8-3**) which is similar in nature to the BLM Class V. TBNG lands in the PRB study area have been inventoried with two scenic integrity levels, Low and Moderate. A Low scenic integrity level refers to landscapes where the valued landscape character appears moderately altered. Most of the TBNG lands in the study area are managed with the scenic integrity level of Low, as the grassland landscape appears moderately altered by oil, gas, and mineral development, and, to a lesser extent, some grazing improvements (e.g., fences). The Moderate scenic integrity level refers to landscapes where the valued landscape character appears slightly altered. Portions of TBNG lands along Antelope Creek and east of SR 59 in Converse County are assigned a scenic integrity level of Moderate.

Visual management objectives for SIOs are associated with desired landscape character for each management area and are based on the intent of the management area direction. The desired condition for landscapes in each of the seven management areas within the PRB study area is summarized in **Table 2.8-4**.

Counties. The Sheridan County Growth Management Plan, a comprehensive master plan for the City of Sheridan and Sheridan County, was prepared in 2001 (Sheridan County 2001a). One of the primary themes identified in the plan is to maintain a community character that preserves the quality of life, values, and traditions of the area. Pursuant to this theme, Goal D of the plan encourages the county to inventory "natural or scenic resource areas," among other things, with the ultimate intent of requiring mitigation before a development that would affect the resource could proceed (Sheridan County 2001a).

The City of Gillette and Campbell County jointly have prepared a Comprehensive Planning Program, last updated in 1994. The program identifies parks and recreation planning, including landscaping and beautification, as an essential element determining the character and quality of an environment. The program recommendation is that where industrial areas are located adjacent to residential areas, landscaping should be developed into the buffer zone between two uses.

The General Land Use Plan for Converse County was developed in 1978 and revised in 2003. The Converse Plan does not identify any objectives or policies for scenic resources or landscape character in the county.

Table 2.8-3
USFS Scenery Management System Scenic Integrity Objectives

Class	Description
Very High (Unaltered) Preservation	Very High scenic integrity refers to landscapes where the valued landscape character "is" intact with only minute, if any, deviations. The existing landscape character and sense of place is expressed at the highest possible level.
High (Appears Unaltered) Retention	High scenic integrity refers to landscapes where the valued landscape character "appears" intact. Deviations may be present, but must repeat form, line, color, texture, and pattern common to the landscape character so completely and at such scale that they are not evident.
Moderate (Slightly Altered) Partial Retention	Moderate scenic integrity refers to landscapes where the valued landscape character "appears slightly altered." Noticeable deviations must remain visually subordinate to the landscape character being viewed.
Low (Moderately Altered) Modification	Low scenic integrity refers to landscapes where the valued landscape character "appears moderately altered." Deviations begin to dominate the valued landscape character being viewed, but they borrow valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed, but compatible or complimentary to the character within.
Very Low (Heavily Altered) Maximum Modification	Very low scenic integrity refers to landscapes where the valued landscape character "appears heavily altered." Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles within or outside the landscape being viewed. However, deviations must be shaped and blended with the natural terrain (landforms) so that elements such as unnatural edges, roads, landings, and structures do not dominate the composition.
Unacceptably Low	Scenic integrity refers to landscapes where the valued landscape character appears extremely altered. Deviations are extremely dominant and borrow little if any form, line, color, texture, pattern, or scale from the landscape character. Landscapes at this level of integrity need rehabilitation. This level should only be used to inventory existing integrity. It must not be used as a management objective.

Source: USFS 1995.

Johnson County currently does not have countywide zoning districts, land use districts, or a comprehensive land use plan; however, the county promulgated a Draft Comprehensive Land Use Plan in June 2004, which currently is under review (Johnson County 2004). The Buffalo/Johnson Joint Land Use Plan, which was adopted in August 2001, primarily addresses land uses adjacent to the residential areas within less than 10 miles of Buffalo. This plan will be superseded when the new comprehensive plan is adopted. Although the draft comprehensive plan recognizes the value of scenic views for attracting tourism, there currently are no specific goals for the management of scenic resources in the county.

Table 2.8-4
Desired Visual Conditions for TBNG Management Areas
within the Study Area

Management Area	Desired Condition for Scenic Values
Black-footed Ferret Reintroduction Habitat	NA
Rangelands with Diverse Natural-appearing Landscapes	Natural appearing landscapes predominate; however, oil and gas facilities may occur and are subordinate to the landscape.
Big Game Range	NA
Dispersed Recreation: High Use	Appears as a natural landscape over large areas, but modifications on a small scale are acceptable and blend with the area's natural features.
General Forest and Rangelands: Range Vegetation Emphasis	These areas are dominated by open meadows, grasslands, shrublands, and areas of woody vegetation. Signs of motorized travel, hunting, hiking, timber harvest, mining, and grazing may be evident.
Rangeland with Broad Resource Emphasis	NA
Mineral Production and Development	Facilities and landscape modifications are visible but are reasonably mitigated to blend and harmonize with natural features. Reclamation activities restore the area to a reasonable level of its pre-mining condition.

Note: NA = not applicable.

Source: BLM 2003a.

Visual Sensitivity

The level of sensitivity to landscape modifications in the study area ranges from low to high. Most of the study area is not visually sensitive because of its remoteness from viewpoints used by the public. The overall population density of the rural portion of the PRB study area is low. Visitor use of most public lands in the study area is light for recreation or other activities. The portions of the area that have relatively higher levels of sensitivity to landscape modification occur near communities, along highway corridors, and at recreation-use areas. A substantial number of residents and visitors exposed to these landscapes would have a concern for scenic quality and would be sensitive to modifications to the landscape. In general, residents and other users of some portions of the area already developed with gas wells and coal mining are accustomed to viewing existing mineral resource development, but could be more sensitive to increased levels of development.

A majority of the more sensitive areas occur in the western part of the study area, including I-25, the cities of Sheridan and Buffalo, and several recreation and historic sites. The I-25 corridor, which connects several study area communities, has the highest levels of traffic of any area highway. Sensitive areas in the remainder of the PRB study area include Gillette and recreational use areas in the eastern part of the study area. Other travel routes include I-90, several state highways, and numerous county roads and BLM roads that access the area from the highways. Public use of BLM roads is relatively low with motorists being in the categories of local ranchers and residents, coal mine and gas field personnel, and some recreationists.

2.8.4 Comparison to Previous Predictions

Noise

Noise forecasts for PRB coal development were not provided in the Eastern Powder River Coal Final EIS (BLM 1979). Estimates in the Powder River Regional Coal Final EIS (BLM 1981) were limited to the potential effects of coal train traffic on downstream communities. Current levels of coal train traffic (see Section 2.9.4) indicate substantially fewer coal trains on Burlington Northern and Santa Fe Railroad (BNSF) lines through Newcastle and Torrington than were predicted in 1981, which indicates noise levels would be commensurately lower than predicted. There was no estimate of rail traffic on the Union Pacific (UP) line through Lusk in either the 1979 EIS or the 1981 EIS. Current levels of coal train traffic on that route are approximately two-thirds of the predicted traffic level for the Newcastle line, which suggests noise levels notably below the level predicted for Newcastle in the 1981 Final EIS.

Visual Resources

Previous forecasts of effects of coal development on visual resources in the PRB were general in nature, indicating reductions in VRM classification at mine sites during active mining followed by returns to pre-mining VRM Class III or IV after successful reclamation. Limited field observations suggest this predicted pattern has been largely accurate. Many of the mines are not readily visible from sensitive or high activity viewing areas, which has minimized the adverse visual effects to some degree.

2.9 Transportation and Utilities

2.9.1 Key Issues

The key transportation and utility issues in the PRB study area include:

- Highway capacity and safety issues from development-related traffic changes;
- Railroad capacity and safety issues related to potential increases in coal production;
- Utility capacity requirements related to increased development; and
- Potential utility ROW/easement requirements and related conflicts with other land uses or transportation corridors.

2.9.2 Study Area

The study area for transportation and utilities includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (see **Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS (see **Figure 1-2**). State and private lands also are included in the study area (see **Figure 1-3**).

2.9.3 Current Conditions

2.9.3.1 Transportation

Highways and Roads

Consistent with the low population density in the study area, the major road network is quite sparse. In the approximately 120-mile by 140-mile PRB study area, there are only two major north-south highways, and one major route with several lesser, two-lane primary highways running east and west (see **Figure 1-1**). I-25 runs north and south along the west side of the study area, intersecting I-90 at Buffalo; I-90 continues northwesterly through Sheridan and on to Billings, Montana, and easterly through Gillette, across northeast Wyoming, and on to Rapid City, South Dakota. South of Buffalo, I-25 runs through Casper, Douglas, Wheatland, and Cheyenne and continues on through Colorado's Front Range cities. The other major north-south highway is SR 59 running through the eastern part of the study area from the Montana state line through Weston, Gillette, and Bill, to Douglas and I-25.

I-90 is the primary east-west route through the PRB study area. I-90 is the northernmost continuous interstate route across the U.S. from Seattle to Boston. It crosses the study area from the Montana state line through Sheridan, Buffalo, and Gillette and exits Wyoming into South Dakota. Primary, two-lane east-west highways include U.S. Highway 14 and 16 on a northerly route from Gillette to I-90 at Sheridan (U.S. Highway 14) and Buffalo (U.S. Highway 16), and SR 387 from Reno Junction/Wright to I-25 at Midwest, just outside of the study area.

Several short segments of U.S. highways and secondary state roads and numerous county roads also provide local access to public and private lands in the study area. In addition, there is a complex network of essentially unimproved, and only minimally maintained, local roads serving the area, some of which are not open to public access without landowner permission.

Traffic volumes on the road network in the study area are highly variable. The highest volume counts are found on major roadways in or near the largest communities. In rural areas, the interstate highways (I-90 and I-25) carry the largest traffic volumes, followed by major state highways. Traffic volumes for major roads are presented in **Table 2.9-1**. Current traffic volumes are well within the capacity of major highways in the study area.

There is no readily discernible pattern to changes in traffic volumes over the past 5 years, except that the largest numerical increases generally have occurred in or near the larger communities (see **Table 2.9-1**). Other than that, the rates of change in traffic volumes have varied a great deal throughout the study area. The percent changes in traffic volumes were larger from 1998 to 2003 than from 1994 to 1998, primarily in the Gillette and Sheridan areas. This change in traffic growth rates tracks with the increased population growth rates in Campbell and Sheridan counties in the latter half of the past decade, which have been driven by increases in coal and CBNG employment (**Table 2.9-1**).

There are numerous improved and unimproved (four-wheel drive) roads within the study area. BLM transportation planning for the study area is discussed in the updated RMPs for the Buffalo and Casper field offices (BLM 1977; 2001). Based on BLM Manual, Section 9113 (BLM 1985), roads on BLM lands are classified, based on the amount of traffic movement, into three classes: collector, local, and temporary resource roads. Collector roads generally provide access to large land tracts and are the major access routes into development areas with relatively high average daily traffic rates. They usually connect with or are extensions of public road systems and are operated to support long-term land uses. Local roads normally serve a smaller area and have lower traffic volumes than collector roads. They connect with collectors or public road systems. In mountainous terrain, local roads may be single lane roads with turnouts. Resource roads generally are point access or spur roads that connect with local or collector roads and carry low traffic volumes.

The BLM and USFS are responsible for ensuring that new roads on federal lands meet the criteria for design and construction. BLM minimum road design and maintenance requirements are provided in BLM Manual, Section 9113 – Roads (BLM 1985).

New roads across non-federal lands would have to comply with the design and maintenance requirements of the State of Wyoming and local jurisdictions, mainly counties. An access permit from WYDOT would be required before a new road connection to a state highway could be constructed. An access permit also would be required before an existing private or ranch road accessing a state highway could be converted to public use.

Many of the existing roads within the study area need repairs or improvement. The fiscal year (FY) 2005 Surface Transportation Improvement Program (STIP), prepared by the WYDOT Planning Program, identified 184 projects addressing over 625 miles of roadway in the state (WYDOT 2004). Major projects scheduled for construction in the study area include widening and resurfacing of 5 miles of I-25 north of Buffalo, adding 33 miles of passing/climbing lanes to SR 59 in the Reno

Table 2.9-1
Annual Average Daily Traffic Counts

County	Route	Location	AADT[1] Counts by Year				Percent Change					
			1994	1998	1999	2003	1994-1998	Average Annual	1998-2003	Average Annual	1994-2003	Average Annual
Campbell	I-90	SR 59 intersection	5,460	6,070	6,380	7,710	11.2	2.7	27.0	4.9	41.2	3.9
	I-90	Gillette east urban limits	5,360	5,970	6,100	7,670	11.4	2.7	28.5	5.1	43.1	4.1
	I-90	Wyodak intersection	5,050	5,660	5,790	6,250	12.1	2.9	10.4	2.0	23.8	2.4
	U.S. Hwy 14-16	Rozet intersection	4,590	5,100	5,320	6,080	11.1	2.7	19.2	3.6	32.5	3.2
	SR 50	Savageton	460	500	550	690	8.7	2.1	38.0	6.7	50.0	4.6
	SR 59	Wyoming-Montana State line	290	300	300	360	3.4	0.9	20.0	3.7	24.1	2.4
	SR 59	Gillette, Lakeway Road south urban limits	17,170	18,690	17,760	17,180	8.9	2.1	-8.1	-1.7	0.1	0.0
	SR 59	Reno Junction (Wright)	2,210	2,150	2,250	2,790	-2.7	-0.7	29.8	5.3	26.2	2.6
	SR 59	Campbell-Converse County line	1,060	1,350	1,450	1,200	27.4	6.2	-11.1	-2.3	13.2	1.4
	SR 387	Campbell-Johnson County line	1,040	1,110	1,210	1,200	6.7	1.6	8.1	1.6	15.4	1.6
Converse	SR 59	Bill	1,280	1,350	1,450	1,350	5.5	1.3	0.0	0.0	5.5	0.6
Johnson	I-90	Junction I-25 (Buffalo tri-level intersection)	2,950	3,680	3,700	3,900	24.7	5.7	6.0	1.2	32.2	3.2
	I-90	Johnson-Campbell County line	3,950	5,030	5,140	4,440	27.3	6.2	-11.7	-2.5	12.4	1.3
	I-25/U.S. Hwy 87	Junction Kaycee interchange	2,400	2,800	2,802	3,030	16.7	3.9	8.2	1.6	26.3	2.6
Sheridan	I-90/U.S. Hwy 87	Wyoming-Montana State line	3,360	3,710	3,760	3,860	10.4	2.5	4.0	0.8	14.9	1.6
	I-90	Sheridan-Johnson County line	4,830	5,700	5,970	6,250	18.0	4.2	9.6	1.9	29.4	2.9
	U.S. Hwy 14	I-90	2,250	2,400	2,400	2,270	6.7	1.6	-5.4	-1.1	0.9	0.1
	U.S. Hwy 14-16	Ucross Junction	460	560	560	580	21.7	5.0	3.6	0.7	26.1	2.6
	U.S. Hwy 14-16	Sheridan-Campbell County line	170	180	180	400	5.9	1.4	122.2	17.3	135.3	10.0
	U.S. Hwy 16	Sheridan-Johnson County line	270	260	280	350	-3.7	-0.9	34.6	6.1	29.6	2.9
	SR 336	Sheridan east urban limits	3,950	4,100	4,200	5,500	3.8	0.9	34.1	6.1	39.2	3.7
	SR 338	Sheridan north urban limits	970	1,050	1,050	1,610	8.2	2.0	53.3	8.9	66.0	5.8

[1]AADT - average annual daily traffic.

Source: WYDOT 1995, 1999, 2004.

Junction vicinity, reconstructing 11 miles of roadway and a bridge on SR 59 north of Gillette, reconstructing 11 miles of U.S. Highway 14/16 southeast of Spotted Horse, and reconstructing and widening 4 miles of SR 50 (4 J Road) near Savageton Road. The STIP also identifies preliminary engineering activities for projects planned through FY 2010.

The four counties in the study area have given varying degrees of attention to planning for transportation improvements. The general transportation planning goals for Campbell County are discussed in the City of Gillette/Campbell County Comprehensive Planning Program (City of Gillette and Campbell County 1994). They indicate traffic generation and potential traffic conflicts would be considered in evaluating new developments and zoning changes. The county currently is replacing scoria-surfaced roads with river gravel to reduce dust. Johnson County has no formal transportation plan. Sheridan County's Growth Management Plan (Sheridan County 2001a) recommends development of a Sheridan Urban Transportation Plan. Transportation issues identified in the Converse County Land Use Plan (Converse County 2003) include paving and other improvements required to accommodate traffic from increased residential development and mineral extraction and processing in rural areas where gravel roads previously were suitable.

Railroads

Two major rail lines serve the study area (**Figure 1-1**). The BNSF enters Sheridan County from Montana north of Sheridan, runs southerly through the city, and then southeast through Clearmont to the City of Gillette in Campbell County. From Gillette, the railroad continues southeasterly to South Dakota. A secondary route jointly operated by BNSF and UP, primarily serving coal trains from PRB mines, generally heads straight south from Gillette into Converse County toward Douglas where it splits into southerly and easterly branches. There is a major marshalling yard and repair facility about 5 miles south of Bill. Several spur lines connect the railroad with existing and historical mines in the area. The typical ROW corridor for the railroad in the study area is 400 feet wide (BLM 2001b).

Current coal train traffic averages approximately 144 coal unit trains (loaded and empty) per day; 110 on the southern route and 34 on the northern route (Bartlett 2004, Roark 2004). The number of trains is very close to the number predicted for 1995 in the Powder River FEIS Coal (BLM 1981). The volume of coal shipped is greater than predicted, however, because trains today range from 118 to 135 100-ton cars, rather than the 100 100-ton cars predicted in 1981. Over 75 percent of the coal trains currently head south out of the PRB, compared to a nearly even north-south split predicted earlier. The difference has been accommodated by upgrading the line south of Bill, Wyoming, to a triple track configuration.

Airports

Three public airports exist in the study area (AirNav.com 2001). The Gillette-Campbell County Airport is located 4 miles northwest of Gillette. The Gillette very high frequency omnidirectional range (VOR) (radio aid used for navigation) is located at the airport. The Sheridan County Airport and VOR are located southwest of the City of Sheridan. All development within the Sheridan County designated Airport Zone must comply with the Airport Master Plan (Barnard Dunkelberg & Company 1996). The Johnson County Airport and Crazy Woman VOR are located 3 miles northwest of the City of Buffalo.

Federal Aviation Administration (FAA) regulations require a 2-mile radius safety zone around airports to promote air navigational safety at the airport, and to reduce the potential for safety hazards for property and for persons on lands near airports. FAA regulations also require filing a notice (FAA Form 7460-1) for construction projects which extend 200 feet or greater above natural terrain and are located within 5 miles of an airport. Portions of the study area are located within the 2-mile safety zones for these airports.

2.9.3.2 Utilities

Electric Transmission

There are two major electric power line corridors through the study area, both running in a generally north-south direction. Both corridors contain 230-kilovolt power lines. The westerly corridor essentially parallels the I-90 corridor southward from the Montana border, passes around the City of Sheridan on the east, passes the City of Buffalo, also on the east side, and then connects into the I-25 corridor, which it parallels through Casper, Douglas, and on south to the Laramie River Station near Wheatland. The second major electric transmission corridor runs along the east side of the study area. As part of the regional grid, it connects the Wyodak/Neil Simpson/Wygen Power Plant complex near Gillette to the 750-megawatt Dave Johnston Power Plant operated by PacificCorp near Glenrock.

Pipelines

The PRB study area is crossed by an extensive network of oil and gas transportation pipelines due to its history of oil and natural gas production. Currently, the gas collection network is expanding as new areas are being developed for CBNG production. Among the major crude oil lines are the 18-inch Belle Fourche pipeline running northeast from a junction near Kaycee to the Montana state line near the Campbell – Crook county line, and the 18-inch Rocky Mountain Pipeline System line running south to Casper from the same junction northeast of Kaycee.

There are numerous large diameter natural gas pipelines carrying gas from the extensive network of gathering lines to markets outside the basin, mainly to the south. There are a pair of parallel 24-inch Fort Union Gas Gathering System lines running nearly straight south from southeast of Gillette to the I-25 corridor west of Douglas. There is a 24-inch Thunder Creek Gas Services line also running nearly straight south from gas fields northwest of Gillette to the I-25 corridor between Douglas and Casper. There are two 16-inch lines running southerly from the Western Gas Resources processing plant northeast of Wright. One is a Kinder Morgan operating line, which parallels SR 59 into Douglas. The other is a McCulloch Interstate Gas Company line, which runs approximately 15 miles farther west, crossing the I-25 corridor west of Douglas. There are numerous smaller natural gas gathering and transmission lines lacing across the PRB that are operated by more than a dozen pipeline companies (De Bruin 2002).

2.9.4 Comparison to Previous Predictions

The Eastern Powder River Coal Final EIS (BLM 1979) predicted approximately 104 unit trains per day into and out of the PRB in 1990, half of which would be loaded and the other half returning

empties. Approximately 58 of the 104 would be using the northern route and 46 would be using the southern route. The Powder River Regional Final EIS (BLM 1981) is not clear as to how many coal trains it anticipated, but it apparently predicted 71 trains per day on the southern route and 74 on the northern route in 1995. In comparison to these early estimates, current coal train traffic averages approximately 144 coal unit trains (loaded and empty) per day; 110 on the southern route and 34 on the northern route (Roark 2004; Bartlett 2004).

In addition, there have been substantial technological changes in the rail transport of PRB coal in the past 25 years. The early rail traffic estimates assumed trains of 100 cars, each carrying 100 tons of coal, pulled by 5 locomotives. In contrast, current trains range from 118 to 135 100-ton cars (most at the upper end of the range) pulled by three locomotives. These changes have been made possible by advancements in horsepower, adhesion, fuel efficiency, exhaust emissions, and electronic controls for the locomotives (Godsil 2004).

No new “greenfield” railroad main lines have been built in the PRB since the north-south route through the basin was built. This joint UP/BNSF line, operated by BNSF, is being upgraded in 2004 and 2005 from a double track to a triple track between Shawnee Junction, east of Douglas, to Mile Post 58, approximately 27 miles north of Bill (Brandt 2004). This upgrade has required minor widening of the ROW, but no major land acquisition (Godsil 2004).

2.10 Hazardous Materials and Wastes

2.10.1 Key Issues

As industrial development in the PRB has increased, so too has the use of hazardous materials and the disposal of hazardous waste. Air, water, soil, and biological resources potentially could be affected by an accidental release or misuse of hazardous materials that could occur during transportation, storage, or use for various industrial activities.

2.10.2 Study Area

The baseline study area for hazardous materials includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (see **Figure 1-1**). It includes all of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the USFS. State and private lands also are included in the study area (see **Figure 1-3**).

2.10.3 Current Conditions

2.10.3.1 Regulatory Framework

"Hazardous materials" are defined in various ways under a number of regulatory programs. The term hazardous materials includes materials regulated by the statutes and regulatory programs listed below. Many of the hazardous materials or substances are regulated under more than one program.

- Substances covered under the Occupational Safety and Health Administration Hazard Communication Standard (29 CFR 1910.1200).

- “Hazardous materials" as defined under the U.S. Department of Transportation (USDOT) regulations at 49 CFR, Parts 170-177.

- “Hazardous substances” as defined by the Comprehensive Environmental Response, Compensation, and Liability Act and listed in 40 CFR Table 302.4.

- “Hazardous wastes” as defined in the Resource Conservation and Recovery Act (RCRA). Procedures in 40 CFR 262 are used to determine whether a waste is hazardous waste. RCRA regulations have specific definitions of what constitutes hazardous waste and how such wastes are managed and disposed.

- Any “hazardous substances” or "extremely hazardous substances," as well as petroleum products such as gasoline, diesel, or propane, that are subject to reporting requirements (Threshold Planning Quantities) under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act (SARA).

- Petroleum products defined as "oil" in the Oil Pollution Act of 1990. The types of materials subject to these requirements include fuels, lubricants, hydraulic oil, and transmission fluids.

In conjunction with the definitions noted above, the following lists provide information regarding management requirements during transportation, storage, and use of particular hazardous chemicals, substances, or materials:

- The SARA Title III List of Lists or the Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act and Section 112(r) of the Clean Air Act.

- The USDOT listing of hazardous materials at 49 CFR 172.101.

Certain types of materials (e.g., used oil) while they may contain potentially hazardous constituents, are specifically exempted from regulation as “hazardous wastes.” WDEQ also has regulations concerning management of certain types of hazardous materials. Other wastes that otherwise might be classified as hazardous are managed as “universal wastes” and are exempt from hazardous waste regulation as long as those materials are handled in ways specifically defined by regulation. An example of a material that could be managed as a universal waste is lead-acid batteries. As long as lead-acid batteries are recycled appropriately, requirements for hazardous waste do not apply.

In most cases, the regulated materials consist of products and materials that are used and consumed during industrial activities. Examples of such materials could include cement, fuel, solvents, acids, and many of other chemicals and products. Often the hazardous constituents comprise a small percentage of the product being used, the rest of the material in the product being inert or not defined as hazardous under any of the programs listed above. If these materials are not consumed during ordinary use and are regarded as waste, and if a waste is determined to be a hazardous waste, it must be handled and disposed of according to strict rules under RCRA. The RCRA program in Wyoming is delegated to the Hazardous and Solid Waste Division of the WDEQ. If the material to be discarded is determined not to be a hazardous waste, the material must be disposed of or recycled in a manner according to the statutes and regulations.

2.10.3.2 Coal Mining and Other Mining Operations

The primary hazardous materials that are consumed during coal mine operations include petroleum fuels and lubricants. **Table 2.10-1** presents a generic list of potentially hazardous materials typically used in surface coal mining operations. The amounts of these materials would vary considerably from mine to mine based on production methods and overall output from the mine. The fuel used is primarily diesel for excavators, heavy equipment, and haul trucks. The fuels are stored at the various mines in tanks (whether aboveground or underground) that have release containment systems and spill contingency plans to handle leaks and larger spills.

In addition to storage of fuels and lubricants in stationary tanks, mobile tanker trucks are used to provide fuel for excavators, haul trucks, and other equipment. Portable tanks and drums also would be stored in a manner to prevent spills from reaching soils or water. Used oil would be recycled to a licensed used oil recycler during the life of the mine.

Table 2.10-1
Potentially Hazardous Materials Used in Typical Surface Coal Mining Operations

Material	
Diesel	Brake fluid
Gasoline	Grease
Explosives	Lead-acid batteries
Gear lubricant	Solvents (i.e., petroleum naptha)
Engine lubrication oil	Chlorine (for water supply treatment)
Hydraulic oil	Herbicides
Ethylene glycol (antifreeze)	Dewatering well treatment chemicals (i.e. hydrochloric acid)

Source: U.S. Army Corps of Engineers 2002.

During the operational lives of the mines, the probability of minor spills of materials such as fuel and lubricants would be relatively high. These releases could occur during fueling operations or from equipment failure (e.g., hydraulic hose failure). Spills of this nature would be localized, contained, and disposed of in accordance with the applicable laws and regulations. Accidents involving other hazardous materials also could occur during mine operation. Mine operations are required to develop and maintain a site-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan to deal with unplanned releases of petroleum products. They also have Emergency Response Plans that establish procedures for responding to accidental spills or releases of hazardous materials to minimize health risks and environmental effects. The plans include procedures for evacuating personnel, maintaining safety, cleanup and neutralization activities, emergency contacts, internal and external notifications to regulatory authorities, and incident documentation. Proper implementation of the SPCC and Emergency Response plans has reduced the potential for major impacts associated with potential releases of hazardous materials.

Some of the materials listed above may become hazardous wastes (i.e., spent solvents). Materials that are considered hazardous must be accumulated, transported, and disposed of under very specific requirements. A review of the USEPA's Enforcement and Compliance History Online database indicates that the coal mines in the PRB do not generate large amounts of hazardous waste, and most of the mines are classified as Small Quantity Generators or Conditionally Exempt Small Quantity Generators.

2.10.3.3 Conventional Oil and Gas, Coal Bed Natural Gas, and Pipelines

Drilling operations for conventional oil and gas, and CBNG are very similar. Many of the potentially hazardous materials used in drilling the wells are the same. However, the amounts of material used for CBNG wells are somewhat less, because the wells generally are much shallower. The materials used in these industries include fuels, lubricants, additives, and explosives. **Table 2.10-2** lists the types of hazardous materials that could be used for drilling and completion operations.

In addition to materials used in the drilling of wells, there are materials that are used and consumed in the production operations of oil and natural gas wells. Some of the common materials are listed in **Table 2.10-3**. Some materials may be used exclusively for oil well operations and others used exclusively for gas wells and associated gas processing and compression.

Table 2.10-2
Potentially Hazardous Materials Used in Typical Oil and Gas Well Drilling and Completion Operations

Material	
Diesel	Engine lubricants
Gasoline	Biocides
Drilling fluid additives	Solvents
Caustics	Paint and thinners
Well completion and treatment fluid and additives	Pipe thread sealer
Silica sand	Explosives (for perforating)
Corrosion inhibitors	Compressed gases
Cement	Lead-acid batteries
Cement additives	Ethylene glycol
Hydraulic fluids	

Sources: BLM 2003a; USFS and BLM 2003.

Table 2.10-3
Potentially Hazardous Materials Used in Typical Oil and Gas Well Production Operations[1]

Material	
Well workover treatment chemicals	Methanol (line freezing prevention, gas wells)
Emulsion breakers (oil wells)	Water treatment chemicals
Corrosion inhibitors	Catalysts (natural gas processing, sulfur recovery)
Triethylene glycol (natural gas dehydration)	Caustics (gas treatment)
Biocides	Paint and thinners
Diesel	Lead-acid batteries
Gasoline	Herbicides
Amines (natural gas processing)	

[1]Includes field gas processing and gathering pipelines.

Source: Interstate Oil and Gas Compact Commission 1999.

Oil and gas well operators also must comply with requirements for the transportation, storage, use, and disposal of potentially hazardous materials. In addition, certain wastes derived from oil and gas drilling and production operations are exempt from regulation as hazardous wastes. Instead, these waste materials must be disposed of or recycled according to applicable rules and regulations either under the jurisdiction of WDEQ or WOGCC. Examples of wastes that are exempt include produced water, drilling mud and cuttings, and completion and workover fluids.

In addition to the potentially hazardous materials that would be used and generated during oil and gas drilling and production operations, the products derived there from are considered hazardous. Oil, condensate, natural gas liquids, and methane can be considered hazardous materials either because of their volatility or explosive nature. There are standards and regulations that apply as well to the storage and transportation of these products.

Natural gas pipelines also would use potentially hazardous materials. Materials typically used in the construction and operation of transportation pipelines includes fuels (diesel, gasoline, methane), lubricants, water treatment chemicals, ethylene glycol, propylene glycol, methanol, sand blast media, and acids.

2.10.4 Comparison to Previous Predictions

A review of previous NEPA documents (BLM 1979, 1981) and the Coal Development Status Check (BLM 1996) indicated that specific historical information is not available, nor were predictions made, concerning the transportation, storage, use, and disposition of hazardous materials (e.g., kind of materials, amounts used, spills and releases, and trends of consumption for the future) for coal mining.

3.0 REFERENCES

Advanced Resources International. 2002. Powder River Basin Coalbed Methane Development and Produced Water Management Study. November 2002. Internet web site: http://www.netl.doe.gov/scng/policy/refshelf/PowderRiverBasin.pdf.

AirNav.com. 2001. Airport Information for County Airports. Internet web site: http://www.airnav.com/airports/us/wy.

Anderson, S. H. and J. R. Squires. 1997. The Prairie Falcon. University of Texas Press, Austin. 162 pp.

Anderson, W. L. 1978. Waterfowl Collisions with Power Lines at a Coal-fired Power Plant. Wildlife Society Bulletin 6:77-83.

Avian Power Interaction Committee (APLIC). 1996. Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996. Edison Electric Institute and the Raptor Research Foundation, Washington, D. C.

_____. 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute, Washington, D. C.

Ayers, W. B., Jr. 2002. Coalbed Gas Systems, Resources, and Production Review Contrasting Cases from the San Juan and Powder River Basins. American Association of Petroleum Geologists Bulletin, v. 86, no. 11. pp. 1853-1890. November 2002.

Baker, W. L. and G. K. Dillon. 2000. Plant and Vegetation Responses to Edges in the Southern Rocky Mountains. pp. 221-245. In: Forest Fragmentation in the Southern Rocky Mountains. R. L. Knight, F. W. Smith, S. W. Buskirk, W. H. Romme, and W. L. Baker, eds. Boulder: University Press of Colorado.

Barnard Dunkelberg & Company. 1996. Sheridan County Airport Master Plan Update. Prepared for Sheridan County, Wyoming. December 1996.

Bartlett, J. 2004. Coal Group, Burlington Northern-Santa Fe Railroad. Personal communication with B. Strom, ENSR. December 16, 2004.

Barrett, N. M. 1998a. Golden Eagle. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 124-125. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998b. Osprey. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 104-105. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998d. Northern Goshawk. In: Colorado Breeding Bird Atlas. H. E. Kingery ed. pp. 116-117. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

3.0 References

Baxter, G. T. and J. R. Simon. 1970. Wyoming Fishes. Wyoming Game and Fish Department, Cheyenne, Wyoming, Bulletin No. 4, 168 pp.

Beaulaurier, D. L., B. W. J., P. A. Jackson, J. R. Meyer, and J. M. Lee, Jr. 1982. Mitigating the Incidence of Bird Collisions with Transmission Lines. Presented at the Third International Symposium on Environmental Concerns in Rights-of-Way Management. San Diego, California.

Beauvais, G. P. 2001. Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*) in Wyoming: Status Report. Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming. July 2001.

Boeker, E. L. 1974. Status of Golden Eagle Population Studies in the Southwest. The Condor 73:463-467.

Boyle, S. 1998a. Short-eared Owl. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 226-227. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998b. Great Horned Owl. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 216-217. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Bradshaw, B. 1996a. Powder River Basin Management Plan (FXSN8PR). Wyoming Game and Fish Department, Sheridan, Wyoming.

_____. 1996b. Cheyenne River Basin Management Plan (FXSN8CR). Wyoming Game and Fish Department, Sheridan, Wyoming.

Brandt, P. 2004. Superintendent. Union Pacific Railroad, Joint UP-BNSF Dispatch Center, Fort Worth, Texas. Personal communication with B. Strom, ENSR. December 15, 2004.

Braun, C. E. 1986. Changes in Sage Grouse Lek Counts with Advent of Surface Coal Mining. Proc. Issues and Technology in the Management of Impacted Western Wildlife, Thorne Ecological Institute, 2:227-231.

Braun, C. E., T. Britt, and R. O. Wallestad. 1977. Guidelines for Maintenance of Sage Grouse Habitats. Wildlife Society Bulletin, 5(3): 99–106.

Brinson, M. M., B. L. Swift, R. C. Plantico, and J. S. Barclay. 1981. Riparian Ecosystems: Their Ecology and Status. FWS/OBS-81/17. U.S. Fish and Wildlife Service, Biological Service Program, Washington, DC. 151 pp.

Brown, B. T. and L. E. Stevens. 1997. Winter Bald Eagle Distribution is Inversely Correlated with Human Activity Along the Colorado River, Arizona. Journal of Raptor Research, 31(7):7-10.

Bureau of Land Management (BLM). 2004. PRB Land Status Map (GIS files for coal mine disturbance areas). October 2004.

_____. 2003a. Final Environmental Impact Statement and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project. Wyoming State Office and Buffalo Field Office. January 2003.

_____. 2003b. Howell Petroleum Corporation Carbon Dioxide Pipeline Project; Environmental Assessment, EA No. WY-0606-03-127. Casper Field Office and Lander Field Office. August 2003.

_____. 2003c. South Powder River Basin Coal Environmental Impact Statement. Casper Field Office, Casper, Wyoming. November 2003.

_____. 2003d. Pipeline Guidance for Crossing Stream Channels. Prepared by the Utah BLM. 5 pp.

_____. 2002a. Phoenix Project Final Environmental Impact Statement. U.S. Department of the Interior, Battle Mountain Field Office, Battle Mountain, Nevada. January 2002.

_____. 2002b. BLM Wyoming Sensitive Species Policy and List. September 20, 2002.

_____. 2001a. Reasonable Foreseeable Development Scenario for Oil and Gas Development in the Buffalo Field Office Area, Campbell, Johnson, and Sheridan Counties, Wyoming. Wyoming State Office, Reservoir Management Group, Casper, Wyoming. February 2001.

_____. 2001b. Buffalo Resource Management Plan. U.S. Department of the Interior. Buffalo Field Office, Buffalo, Wyoming. Completed October 1985, updated April 2001.

_____. 2000a. Environmental Assessment for the Belle Ayr 2000 Lease Application (Federal Coal Lease Application WYW151133). Casper Field Office, Casper, Wyoming. Denver, Colorado. December 2000.

_____. 2000b. Wyodak Drainage Coal Bed Methane Environmental Assessment (EA #WY-070-01-034). U.S. Department of the Interior, Buffalo Field Office, Buffalo, Wyoming.

_____. 1998. BLM Manual 8270, General Procedural Guidance for Paleontological Resource Management. U.S. Department of Interior, Bureau of Land Management. July 13, 1998.

_____. 1997a. Standards for Healthy Rangelands and Guidelines for Management of Public Lands Administered by the Bureau of Land Management in the State of Wyoming. U.S. Department of the Interior. Buffalo Field Office, Buffalo, Wyoming.

_____. 1997b. The Platte River Resource Management Plan. U.S. Department of the Interior. Casper Field Office, Casper, Wyoming. Adopted 1985, amended 1989 and 1997.

_____. 1996. Coal Development Status Check, Powder River Federal Coal Region, Montana and Wyoming, Data Tables. Wyoming BLM Buffalo Resource Area, Casper District, and State Office and Montana BLM Powder River Resource Area, Miles City District and State Office. For Presentation at the Powder River Regional Coal Team Meeting Held in Cheyenne, Wyoming, on April 23, 1996.

3.0 References

_____. 1995a. Final Environmental Assessment for the Antelope Coal Lease Application as Applied for by Antelope Coal Company (Federal Coal Lease Application WYW128322). October 1995.

_____. 1995b. Wyoming BLM Mitigation Guidelines. U.S. Department of the Interior. Buffalo Field Office. Buffalo, Wyoming.

_____. 1994. Final Environmental Assessment of the Eagle Butte Coal Lease Application as Applied for by AMAX Land Company (Federal Coal Lease Application WYW124783). June 1994.

_____. 1990. Coal Bed Methane Environmental Assessment. BLM Buffalo Resource Area, Buffalo Wyoming. April 1990.

_____. 1986a. Visual Resource Inventory (BLM Manual, Handbook 8410-1). U.S. Department of the Interior. Washington, D.C.

_____. 1986b. Visual Resource Contrast Rating (BLM Manual, Handbook 8431-1). U.S. Department of the Interior. Washington, D.C.

_____. 1985. Bureau of Land Management Manual, Section 9113-Roads. (Engineering Release 9-247). U.S. Department of the Interior. Washington, D.C.

_____. 1984. Powder River Coal Draft Environmental Impact Statement. Casper, Wyoming. January 1984.

_____. 1981. Powder River Coal Region Final Environmental Impact Statement . U.S. Department of the Interior, Wyoming State Office. Cheyenne, Wyoming. December 1, 1981.

_____. 1979. Final Environmental Impact Statement: Proposed Development of Coal Resources in Eastern Powder River Wyoming. U.S. Department of the Interior. Washington, D.C. March 28, 1979.

Burt, W. H. and R. P. Grossenheider. A Field Guide to Mammals of North America. Houghton Mifflin Company, New York, New York.

Busch, D. E. and M. L. Scott. 1995. Western Riparian Ecosystems. In: LaRoe, E. T. et al., editors. Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. U.S. Department of the Interior, Washington, DC. pp. 286–290.

Campbell County. 2000a. Campbell County Zoning Regulations. Campbell County Planning Commission. Gillette, Wyoming. Adopted 1969, Revised August 1, 2000.

_____. 2000b. Campbell County Zoning District Map. Campbell County Engineer's Office, Department of Public Works. Gillette, Wyoming.

Carter, M. F. 1998a. Northern Harrier. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 110-111. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Carter, M. F. 1998b. Yellow-billed Cuckoo. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 204–205. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Carter, V. 1986. An Overview of the Hydrologic Concerns Related to Wetlands in the United States. Canadian Journal of Botany 64: 364-374.

Center for Plant Conservation (CPC). 2004. CPC National Collection Plant Profile. Internet web site: http://www.centerforplantconservation.org/ASP/CPC_ViewProfile.asp?CPCNum=4071. Accessed November 17, 2004.

_____. 2000. CPC National Collection Plan profile. Internet web site: http://www.centerforplantconservation.org/ASP/CPC-ViewProfile.asp?CPCNum=371. Accessed May 6, 2005.

Cerovski, A. O., editor. 2004. Threatened, Endangered, and Nongame Bird and Mammal Investigations; Annual Completion Report. Wyoming Game and Fish Department, Nongame Program, Cheyenne, Wyoming.

Cerovski, A., M. Gorges, T. Byer, K. Duffy, and D. Felley, eds. 2001. Wyoming Bird Conservation Plan, Version 1.0. Wyoming Partners in Flight. Wyoming Game and Fish Department, Lander, Wyoming.

Christensen, R. 2002. Wyoming Department of Environmental Quality (WDEQ), Land Quality Division, Cheyenne, Wyoming. Personal communication (facsimile) with C. Florian, Greystone Environmental Consultants, regarding Summary Report of Coal Permit Totals to Date; Active Coal Mine Permits, Powder River Basin, 1999-2001. July 31, 2002.

Christiansen, T. 2005. Sage-grouse Program Coordinator, Wyoming Game and Fish Department. GIS data provided to A. Grow, ENSR, relative to sage-grouse leks. May 22, 2005.

City of Gillette. 1992. City of Gillette Zoning Ordinance (Ordinance No. 979). City of Gillette Planning Commission, Gillette, Wyoming. September 1992.

City of Gillette and Campbell County. 1994. City of Gillette/Campbell County Comprehensive Planning Program and Gillette Land Use Plan Map. City of Gillette and Campbell County Planning Commissions, Gillette, Wyoming. Adopted June 1978, updated March 1994.

City of Sheridan. 2000. City of Sheridan Zoning Ordinance. City of Sheridan, Wyoming. Adopted 1995, amended April 4, 2000.

Clark, T. W. and M. R. Stromberg. 1987. Mammals in Wyoming. University of Kansas, Museum of Natural History.

3.0 References

Colorado Natural Areas Program. 1998. Native Plant Revegetation Guide for Colorado. Volume III. Colorado Natural Areas Program, Denver, Colorado.

Commonwealth Associates, Inc. 1980. Environmental Baseline Study, Antelope Coal Field.

Connelly, J. W., H. W. Browers, and R. J. Gates. 1988. Seasonal Movement of Sage Grouse in Southeastern Idaho. Journal of Wildlife Management: 52: 116–122.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to Manage Sage Grouse Populations and Their Habitats. Wildlife Society Bulleting 28(4):967-985.

Converse County. 2003. Converse County Land Use Plan. Douglas, Wyoming. Adopted 1978, revised July 15, 2003.

Cooperative Agricultural Pest Survey. 1999. University of Wyoming College of Agriculture CAPS. Internet web site: http://w3.uwyo.edu/~caps/caps.html. Data compiled July 1999.

Craig, L. C., and others, (comp.). 1972. Mississippian System. In: Geologic Atlas of the Rocky Mountain Region: Denver, Colorado. W. W. Mallory, ed. Rocky Mountain Association of Geologists. pp. 100-110.

Curry, W. H. 1971. Laramide Structural History of the Powder River Basin, Wyoming: Wyoming Geological Association Guidebook, 23rd Annual Field Conference, pp. 49-60.

DeBruin, R. 2002. Oil and Gas Fields Map of the Powder River Basin, Wyoming. Map Series 51. Wyoming State Geological Survey. Laramie, Wyoming.

DeBruin, R. H. 2001. Carbon Dioxide in Wyoming. Wyoming State Geological Survey, Laramie, Wyoming. Information Pamphlet No. 8.

_____. and R. W. Jones. 1989. Coalbed Methane in Wyoming. In: Gas Resources of Wyoming. J. L. Eisert. ed. pp. 97-103. Wyoming Geological Association of Geologists 40th Field Conference Guidebook, Casper, Wyoming. September 10-14, 1989.

Debruin, R. H., R. M. Lyman, R. W. Jones, and L. W. Cook. 2001. Coalbed Methane in Wyoming. Information Pamphlet No. 7 (revised). Wyoming Geological Survey, Laramie, Wyoming.

Delson, E. 1971. Fossil Mannals of the Early Wasatchain Powder River Local Fauna, Eocene of Northeastern Wyoming. Bulletin of the American Museum of Natural History: 146:307-364.

Deromodi, J. 1996. North Platte River - Pine Ridge to Nebraska Basin Management Plan. Wyoming Game and Fish Department, Lander, Wyoming.

Diamond, W. P. 1993. Methane Control for Underground Mines. In: Law, B.E. and D.D. Rice. 1993, Hydrocarbons from Coal. American Association of Petroleum Geologists Studies in Geology No. 38. Tulsa, Oklahoma, pp. 237-267.

Dinsmore, J. J. 1983. Mountain Plover (*Charadrius montanus*). In: Impacts of Coal Surface Mining on 25 Migratory Bird Species of High Federal Interest. J. S. Armbruster, editor. pp. 185-196. U.S. Fish and Wildlife Service FWS/OBS–83/35. 348 pp.

Dorn, J. L. and R. D. Dorn. 1990. Wyoming Birds. Mountain West Publishing, Cheyenne, Wyoming.

Dorn, R. D. 1992. Vascular Plants of Wyoming, Second Edition. Mountain West Publishing, Cheyenne, Wyoming.

Encyclopedia of North American Indians. 2004. Treaty of Fort Laramie (1868). Internet web site: http://college.hmco.com/history/readerscomp/naind/html/na_040500_treatyfl1868.htm.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The Birder's Handbook: A Field Guide to the Natural History of North American Birds. Simon and Schuster, New York.

ENSR Corporation (ENSR). 2005a. Task 2 Report for the Powder River Basin Coal Review Past and Present and Reasonably Foreseeable Development Activities. Prepared for Bureau of Land Management Casper Field Office and Wyoming State Office.

_____. 2005b. GIS analysis of resource-specific map layers in relation to map layers of development-related disturbance as defined for the PRB Coal Review. June 2005.

_____. 2005c. Task 1B Report for the Powder River Basin Coal Review. Prepared for Bureau of Land Management Casper Field Office and Wyoming State Office.

Federal Energy Regulatory Commission (FERC). 2004. Major Pipeline Projects on the Horizon as of February 2004. Internet web site: http://www.ferc.gov/for-citizens/projectsearch/SearchProjects.aspx. Accessed July 2, 2004.

_____. 2003. Grasslands Project Final Environmental Impact Statement (FERC/EIS-0154F). May 2003.

Fertig, W. 2000a. *Spiranthes diluvialis*. Ute Ladies' Tresses. Wyoming Natural Diversity Database State Species Abstract. Internet web site: http://uwadmnweb.uwyo.edu/wyndd/Plants/plant_species.htm. Accessed: July 31, 2002.

_____. 2000b. Status Review of the Ute ladies'-tresses (*Spiranthes diluvialis*) in Wyoming. Wyoming Natural Heritage Diversity Database. Univ. of Wyoming. Laramie, Wyoming. 17 pp.

_____. 2000c. *Aquilegia laramensis*. Laramie Columbine. Wyoming Natural Diversity Database State Species Abstract. Internet web site: http://uwadmnweb.uwyo.edu/wyndd/Plants/plant_species.htm. Accessed: July 31, 2002.

_____. 2000d. *Astragalus nelsonianus*. Nelson's Milkvetch. Wyoming Natural Diversity Database State Species Abstract. Internet web site: http://uwadmnweb.uwyo.edu/wyndd/Plants/plant_species.htm. Accessed: July 31, 2002.

_____. 2000e. *Cleome multicaulis*. Many-stemmed Spider-flower. Wyoming Natural Diversity Database State Species Abstract. Internet web site: http://uwadmnweb.uwyo.edu/wyndd/Plants/plant_species.htm. Accessed: July 31, 2002.

_____. 2000f. *Cymopterus williamsii*. William's Wafer Parsnip. Wyoming Natural Diversity Database State Species Abstract. Internet web site: http://uwadmnweb.uwyo.edu/wyndd/Plants/plant_species.htm. Accessed: July 31, 2002.

_____. 2000g. *Sphaeromeria simplex*. Laramie False Sagebrush. Wyoming Natural Diversity Database State Species Abstract. Internet web site: http://uwadmnweb.uwyo.edu/wyndd/Plants/plant_species.htm. Accessed: July 31, 2002.

Fertig, W. and G. Beauvais. 1999. Wyoming Plant and Animal Species of Special Concern. Unpublished report. Wyoming Natural Diversity Database, Laramie, Wyoming.

Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado Press. 467 pp.

Flores, R. M. and L. R. Bader. 1999. Fort Union Coal in the Powder River Basin, Wyoming and Montana: a Synthesis. In: Fort Union Assessment Team, 1999, Resource Assessment of Selected Tertiary Coal Beds and Zones in the Northern Rocky Mountains and Great Plains Region. U.S. Geological Survey Professional Paper 1625-A, Chapter PS.

Flores, R. M, A. M. Ochs, L. R. Bader, R. C. Johnson, and D. Vogler. 1999. Framework Geology of the Fort Union Coal in the Powder River Basin. In: Fort Union Assessment Team, 1999, Resource Assessment of Selected Tertiary Coal Beds and Zones in the Northern Rocky Mountains and Great Plains Region. U.S. Geological Survey Professional Paper 1625-A, Chapter PF.

Flores, R. M., G. D. Stricker, J. F. Meyer, T. E. Doll, P. H. Norton, Jr., R. J. Livingston, and M. C. Jennings. 2001. A Field Conference on Impacts of Coalbed Methane Development in the Powder River Basin, Wyoming. Impacts and Issues of CBM Development. U.S. Geological Survey Open-file Report 01-126. 26 pages.

Frankel, A., C. Mueller, T. Barnhard, D. Perkins, E. V. Leyendecker, N. Dickman, S. Hanson, and M. Hopper. 1997. Seismic-hazard Maps for the Conterminous United States, Map F - Horizontal Spectral Response Acceleration for 0.2 Second Period (5% of critical damping) with 10% Probability of Exceedance in 50 Years. U.S. Geological Survey Open-File Report 97-131-F.

Garber, C.S. 1994. A Status Survey for Spotted Frogs (*Rana pretiosa*), Wood Frogs (*Rana sylvatica*) and Boreal Toads (*Bufo boreas*) in the Mountains of Southern and Eastern Wyoming. Unpublished report. Wyoming Natural Diversity Database, Laramie, Wyoming.

Gelhard, J. L. and J. Belnap. 2003. Roads as Conduits for Exotic Plant Invasions in a Semiarid Landscape. Conservation Biology 17(2): pp. 420-432.

Gerard, L. 2005. Wildlife Biologist, Bureau of Land Management Buffalo Field Office. Personal communication with R. Daggett, ENSR, relative to trout occurrence in the Powder River watershed. May 2, 2005.

Gilmer, D. S. and R. E. Stewart. 1983. Ferruginous Hawk Populations and Habitat use in North Dakota. Journal of Wildlife Management 47:146-157.

Glinski, R. L. 1998. Golden Eagle. In: The Raptors of Arizona. R.L. Glinski, ed. pp. 112-114. The University of Arizona Press, Tucson, Arizona.

Godsil, T. 2004. Burlington Northern-Santa Fe Railroad. Personal communication with B. Strom, ENSR. December 15, 2004.

Gonzales, J. 2005. Range Management Specialist, Bureau of Land Management. Buffalo Field Office, Buffalo, Wyoming. Personal communication with A. Grow, ENSR. May 13, 2005.

Good, R. E., D. P. Young, and J. Eddy. 2002. Draft Report. Distribution of Mountain Plovers in the Powder River Basin, Wyoming. Solicitation No. KAQ001005. Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. Prepared for BLM, Cheyenne, Wyoming.

Gordus, A. G., H. L. Shivaprasad, and P. K. Swift. 2002. Salt Toxicosis in Ruddy Ducks that Winter on an Agricultural Evaporation Basin in California. Journal of Wildlife Diseases 38(1):124-131.

Griswold, M. 2002. Campbell County Weed and Pest Control District. Personal communication with J. Gonzales, BLM, Buffalo Field Office. August 8, 2002.

Grose, L. T. 1972. Tectonics. In: W. W. Mallory, ed., Geologic Atlas of the Rocky Mountain Region: Denver, Colorado. Rocky Mountain Association of Geologists. pp. 35-44.

Hammerson, G. 1999. Amphibians and Reptiles in Colorado. University Press of Colorado. Niwot, Colorado.

Hanson, B. R., S. R. Grattan, and A. Fulton. 1999. Agricultural Salinity and Drainage. Division and Agriculture and Natural Resources Publication 3375. University of California, Davis, California. 160 pp.

Harlow, D. L. and P. H. Bloom. 1987. Buteos and the Golden Eagle. In: Proceedings of the Western Raptor Management Symposium and Workshop. pp. 102-110. National Wildlife Federation Science and Technology Series No. 12. Washington, D.C. 320 pp.

Harris, R. E. 2003. Industrial Minerals and Uranium Update. In: Wyoming Geo-note No. 77. Wyoming State Geological Survey, Laramie, Wyoming. pp. 20-21.

Holcomb, J. 2004. Rocky Mountain Pipeline Infrastructure: The Need for More Capacity. Rocky Mountain Gas Symposium. Denver, Colorado. February 11, 2004.

_____. 2003. Rocky Mountain Pipeline Assessment, a report prepared for Pace Global Energy Services dated February 7, 2003, and presented at the Rocky Mountain Association of Geologists and Petroleum Technology Transfer Council Coalbed Methane Symposium. Denver, Colorado. June 10, 2003.

3.0 References

Houston, R. S. 1993. Late Archean and Early Proterozoic Geology of Southeastern Wyoming. In: Geology of Wyoming, Vol. 1, Snoke and others, eds. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. pp. 78-116.

Hubert, W. S. 1993. The Powder River: a Relatively Pristine Stream on the Great Plains. In: Proceeding of the Symposium on Restoration Planning for the Rivers of the Mississippi River Ecosystem, L. W. Hesse, C. B. Stalnaker, N. G. Benson, and J. R. Zuboy, Technical Editors. pp. 387-395. Biology Report 19. U.S. Dept. of the Interior, National Biological Survey, Washington, D.C.

IHS Energy Services™ (IHS). 2004. Oil and Gas Production and Well History Database.

Ingelfinger, F. M. 2001. The Effects of Natural Gas Development on Sagebrush Steppe Passerines in Sublette County, Wyoming. MS Thesis, Department of Zoology, University of Wyoming, Laramie.

Interstate Oil and Gas Compact Commission. 1999. Revised Guide to Waste Minimization in Oil and Gas Exploration and Production.

Irwin, L. L. and J. M. Peek. 1983. Elk Habitat Use Relative to Forest Succession in Idaho. Journal of Wildlife Management 47(3):664-672.

Jahnke, L. 2005. Wildlife Management Coordinator, Wyoming Game and Fish Department, Sheridan, Wyoming. Personal communication with B. Strom, ENSR. May 20, 2005.

Janssen, B. 2004. BLM, Wyoming State Office. Personal communication with B. Strom, ENSR, December 9, 2004.

Johnsgard, P. A. 1986. Birds of the Rocky Mountains. Colorado Association University Press, Boulder, Colorado. 504 pages.

Johnson County. 2004. Draft Johnson County Comprehensive Land Use Plan, June 2004 Revision. Internet web site: http://www.johnsoncountywyoming.org/forms&pubs.html.

Jones, S. 1998a. Burrowing Owl. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 220-221. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998b. Olive-sided Flycatcher. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 268-269. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Jones, S. R. 1998c. Prairie Falcon. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 130-131. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Kantrud, H. A. and R. E. Stewart. 1977. Use of Natural Basin Wetlands by Breeding Waterfowl in North Dakota. Journal of Wildlife Management 41:243-253.

Keinath, D. and J. Bennet. 2000. Distribution and Status of the Boreal Toad (*Bufo boreas boreas*) in Wyoming. Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming.

Keinath, D. A. and D. S. Ehle. 2001. Survey for Mountain Plover (*Charadrius montanus*) on Federal Lands in the Powder River Basin. Prepared for J. Carroll, USDI Bureau of Land Management by the Wyoming Natural Diversity Database – University of Wyoming, Laramie, Wyoming.

Keinath, D. A. 2001. Survey for Mountain Plovers (*Charadrius montanus*) in the Henry's Fork Area of the Great Basins Ecoregion. 13 pp. + appendices. Prepared for the Bureau of Land Management, Rock Springs Field Office, Rock Springs, Wyoming.

Klott, J. H. 1987. Use of Habitat by Sympatrically Occurring Sage Grouse and Sharp-tailed Grouse with Broods. M.S. Thesis, University of Wyoming, 82 pp. (check Klott and Lindzey 1989 Great Basin Naturalist 49; 275-278; also Journal of Wildlife Management 54:84-88).

Knight, D. H. 1994. Mountains and Plains: The Ecology of Wyoming Landscapes. Yale University.

Lageson, D. R. and D. R. Spearing. 1991. Roadside Geology of Wyoming. Missoula, Montana, Mountain Press Publishing Co., second edition, 271 pp.

LaGory, K. E., Y. S. Chang, K. C. Chun, T. Reeves, R. Liebich, and K. Smith. 2001. A Study of the Effects of Gas Well Compressor Noise on Breeding Bird Populations of the Rattlesnake Canyon Habitat Management Area, San Juan County, New Mexico. National Energy Technology Laboratory, National Petroleum Technology Office, U.S. Department of Energy, Tulsa, Oklahoma. 90 pp. Final Report May 2001.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. 1980. Atlas of North American Freshwater Fish. North Carolina Biological Survey, Publication # 1980-12, 854 pp.

Levad, R. 1998. Purple Martin. In: Kingery, H.E., ed. Colorado Breeding Bird Atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado. pp. 334-335.

Lewis, S. 2002. Converse County Weed and Pest Control District. Personal communication with J. Gonzales, BLM – Buffalo field Office. August 2002.

Litzel, R. 2002. Johnson County Weed and Pest Control District. Personal communication with J. Gonzales, BLM Buffalo Field Office. August 1, 2002.

Love, J. D., A. C. Christiansen, and A. J. Ver Ploeg. 1993. Stratigraphic Chart Showing Phanerozoic Nomenclature for the State of Wyoming. Wyoming Geological Survey Map Series No. 41. Laramie, Wyoming.

Love, J. D., A. C. Christiansen, and L. W. McGrew. 1987. Geologic Map of the Newcastle 1˚ x 2˚ Quadrangle, Northeastern Wyoming and Western South Dakota. Wyoming State Geological Survey Map Series 25-1.

Love, J. D. and A. C. Christiansen. 1985. Geologic Map of Wyoming: U.S. Geological Survey Special Geologic Map, scale 1:500,000.

Luce, B., A. Cerovski, B. Oakleaf, J. Priday, and L. Van Fleet. 1999. Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming. Wyoming Game and Fish Department, Wildlife Division, Cheyenne, Wyoming.

Lupcho, P. 1998. Soil Survey of Sheridan County Area, Wyoming. Natural Resource Conservation Service in cooperation with the Wyoming Agricultural Experiment Station.

Lyman, R. M. 2003. Coal Update. In: Wyoming State Geological Survey, Wyoming Geo-notes Number 77. Laramie, Wyoming. June 2003.

Lyon, A. G. 2000. The Potential Effects of Natural Gas on Sage Grouse (*Centrocercus urophasianus*) near Pinedale, Wyoming. MS Thesis, University of Wyoming. 121 pp.

Lyon, L. J. 1983. Road Density Models Describing Habitat Effectiveness of Elk. Journal of Forestry 81:592 595.

_____. 1979. Habitat Effectiveness for Elk as Influenced by Roads and Cover. Journal of Forestry. pp. 658-660.

McDowell, B. 1996a. Belle Fourche River Basin Management Plan (FXSN8BF). Wyoming Game and Fish Department, Sheridan, Wyoming.

_____. 1996b. Little Bighorn River Basin Management Plan (FXSN8LH). Wyoming Game and Fish Department, Sheridan, Wyoming.

_____. 1996c. Little Missouri River Basin Management Plan (FXSN8LM). Wyoming Game and Fish Department, Sheridan, Wyoming.

McGregor, A. A. 1972. The Powder River Basin. In: Geologic Atlas of the Rocky Mountain Region. W. W. Mallory, ed. Denver, Colorado. Rocky Mountain Association of Geologists. pp. 269-270.

McGookey, D. P., and others (compilers). 1972. Cretaceous System. In: Geologic Atlas of the Rocky Mountain Region. Mallory, W.W., ed. Denver, Colorado. Rocky Mountain Association of Geologists. pp. 190-228.

MDU Resources Group. 2004. Grasslands Pipeline. Internet web site: http://www.grasslandspipeline.com/projoverview.asp. Accessed July 2, 2004.

Medders, K. 2004. Range Management Specialist, Bureau of Land Management Buffalo Field Office. Grazing information provided to J. Alstad, ENSR. March 24, 2004.

Mitsch, W. J. and J. G. Gosselink. 1993. Wetlands. Van Nostrand Reinhold, New York, New York. 722 pp.

Montgomery Watson Harza. 2003. Coal Planning Estimates Report. Prepared for the Bureau of Land Management Wyoming State Office. March 2003.

Mueggler, W. F. 1985. Vegetation Associations. In: DeByle, Norbert V., and Winokur, Robert P. Eds. Aspen: Ecology and Management in the Western United States. General Technical Report RM-119. U.S. Forest Service Rocky Mountain Range and Experiment Station, Fort Collins, Colorado.

Murphey, P. C., P. Robinson, and J. Haessig. 2001. Paleontologic Resources of the Powder River Basin: Summary of Existing Conditions for the Powder River Basin Oil and Gas EIS. Rocky Mountain Paleontology, Longmont, Colorado. 24 pp.

Musselman, P. 2004. Director of Special Projects, Converse County, Wyoming. Personal communication with B. Strom, ENSR. December 9, 2004.

Naugle, D. 2004a. Update on Sage Grouse/Coal Bed Methane Project in the Boulder River Basin. University of Montana, Wildlife Biology Program, College of Forestry and Conservation, Missoula, Montana. 5 pp.

_____. 2004b. From the Field: Outbreak of West Nile Virus in Greater Sage-grouse and Guidelines for Monitoring, Handling, and Submitting Dead Birds. University of Montana, Wildlife Biology Program, College of Forestry and Conservation, Missoula, Montana. 17 pp. July 14, 2004.

National Geographic. 1999. Field Guide to the Birds of North America. Third Edition. National Geographic, Washington, D.C.

Nelson, B. 2004. Range Management Specialist, Bureau of Land Management Casper Field Office. Grazing information provided to J. Alstad, ENSR. March 20, 2004.

Nelson, D. 1998a. Long-billed Curlew. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 182-183. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998b. Upland Sandpiper. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 180-181. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998c. Black Tern. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 194-195. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Nicholoff, S. H., compiler. 2003. Wyoming Bird Conservation Plan. Version 2.0. Wyoming Partners in Flight. Wyoming Game and Fish Department, Lander, Wyoming.

Norling, B. S., S. H. Anderson, and W. A. Hubert. 1992. Roost Sites used by Sandhill Crane Staging Along the Platte River, Nebraska. Great Basin Naturalist 52:253-261.

Oedekoven. O. O. 2003. 2003 Sage Grouse Job Completion Report, Sheridan Region. Wyoming Game and Fish Department.

_____. 2002. Preliminary Sheridan Region Lek Site Data. Wyoming Game and Fish Department.

_____. 2001. Sage Grouse Job Completion Report, Sheridan Region. Wyoming Game and Fish Department.

Olson, R. A. and W. A. Gerhart. 1982. A Physical and Biological Characterization of Riparian Habitat and its Importance in Wyoming. Wyoming Game and Fish Department, Cheyenne.

Patton, T. M. 1997. Distribution and Status of Fishes in the Missouri River Drainage in Wyoming: Implications for Identifying Conservation Areas. Ph.D. Thesis, University of Wyoming, Laramie, Wyoming.

Pennak, R. W. 1989. Fresh-water Invertebrates of the United States. Third Edition. John Wiley and Sons, Inc. New York.

Phillips, R. L., T. P. McEneaney, and A. E. Beske. 1984. Population Densities of Breeding Golden Eagles in Wyoming. Wildlife Society Bulletin 12:269-273.

Picard, M. D. 1993. The Early Mesozoic History of Wyoming. In: Geology of Wyoming, Vol. 1. Snoke and others, eds. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. pp. 211-248.

Pierson, A. 2001. Personal Communication (April 9 Memorandum to BLM field managers and deputy state directors, BLM, Wyoming. RE: Issuance of BLM [Wyoming] Sensitive Species Policy and List).

Postovit, H. R. and B. C. Postovit. 1987. Impacts and Mitigation Techniques. In: Raptor Management Techniques Manual. B. A. Giron Pendleton, B. A. Millsap, K. W. Cline, and D. M. Bird, eds. pp. 183-213. National Wildlife Federation, Washington D.C. 420 pp.

Potter, K. 1998a. American White Pelican. In: Kingery, H. E., ed. Colorado Breeding Bird Atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado. pp. 48-49.

_____. 1998b. Black-crowned Night Heron. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado. pp. 62-63.

Potter, K. and R. Roth. 1998. Fox Sparrow. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado. pp. 474-475.

Preston, C. 1998a. Ferruginous Hawk. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado. pp. 122-123.

Preston, C. R. 1998b. Red-tailed Hawk. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado. pp. 120-121.

_____. 1998c. Swainson's Hawk. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 118-119. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Prink, C., Craig, R. White, and B. Hayes. 2004. Soil Survey of Campbell Conty, Wyoming, Northern Part. Natural Resources Conservation Service in cooperation with the BLM, USFS, and Wyoming Agricultural Experiment Station.

Quimby, D. C. 1951. The Life History and Ecology of the Jumping Mouse, *Zapus hudsonius*. Ecological Monographs 21:61–95.

Radbruch-Hall, D. H., R. B. Colton, W. E. Davies, I. Lucchitta, B. A. Skipp, and D. J. Varnes. 1980. Landslide Overview Map of the Conterminous United States. U.S. Geological Survey Professional Paper 1183.

Reckner, R. 1986. Soil Survey of Converse County, Wyoming, Northern Part. Soil Conservation Service in cooperation with the U.S. Forest Service, Bureau of Land Management, and the Wyoming Agricultural Experiment Station.

Reijnen, R. and R. Foppen. 1995. The Effects of Car Traffic on Breeding Bird Populations in Woodland, IV. Influence of Population Size on the Reduction of Density Close to a Highway. Journal of Applied Ecology 32(1995): 481-491.

Reijnen, R., R. Foppen, and G. Veenbaas. 1997. Disturbance by Traffic of Breeding Birds: Evaluation of the Effect and Considerations in Planning and Managing Road Corridors. Biodiversity and Conservation 6:567-581.

Reijnen, R., R. Foppen, C. T. Braak, and J. Thissen. 1995. The Effects of Car Traffic on Breeding Bird Populations in Woodland, III. Reduction of Density in Relation to the Proximity of Main Roads. Journal of Applied Ecology 32(1995): 187-202.

Reijnen, R., R. Foppen, and H. Meeuwsen. 1996. The Effects of Traffic on the Density of Breeding Birds in Dutch Agricultural Grasslands. Biological Conservation 75(1996): 255-260.

Rice, D. D., B. E. Law, and J. L. Clayton. 1993. Coalbed Gas – An Undeveloped Resource. In: The Future of Energy Gases. G. Howell, and others, eds. U.S. Geological Survey Professional Paper 1570, pp. 389-404.

Roark, T. 2004. Superintendent. Union Pacific Railroad, Morrill, Nebraska. Personal communication with B. Strom, ENSR. December 15, 2004.

Rost, G. R. and J. A. Bailey. 1979. Distribution of Mule Deer and Elk in Relation to Roads. Journal of Wildlife Management 43:634-641.

Rothwell, R. 1992. Antelope, Sage Grouse, and Neotropical Migrants. In: Status and Management of Neotropical Migratory Birds. D. M. Finch and P. W. Stangel, eds. USDA Forest Service General Technical Report RM-229. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Ryder, R. 1998a. Snowy Egret. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 56-57. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998b. White-faced Ibis. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 64-65. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Saab, V. A. and T. D. Rich. 1997. Large-scale Conservation Assessment for Neotropical Migratory Land Birds in the Interior Columbia River Basin. USDA Forest Service, General Technical Report PNW-GTR-399. Portland, Oregon.

Sauer, J. R., J. E. Hines, and J. Fallon. 2001. The North American Breeding Bird Survey, Results and Analysis 1966 – 2000. Version 2001.2, U.S. Geological Survey Patuxent Wildlife Research Center, Laurel, Maryland.

Schroeder, M. A., J. R. Young, and C. E. Braun. 1999. Sage Grouse (*Centrocercus urophasianus*). In: The Birds of North America, No. 425. A. Poole and F. Gill, eds. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Schmitt, K. 2004. Range and Management Specialist, Douglas Ranger District, Medicine Bow-Routt National Forests and Thunder Basin National Grasslands. Grazing information for the southern part of the TBNG provided to J. Alstad, ENSR. August 25, 2004.

Schmutz, J. K. 1984. Ferruginous and Swainson's Hawk Abundance and Distribution in Relation to Land Use in Southeastern Alberta. Journal of Wildlife Management 48:1180-1187.

Schraufnagel, R. A. 1993. Coalbed Methane Production. In: Hydrocarbons from Coal; American Association of Petroleum Geologists Studies in Geology No. 38. B. E. Law and D. D. Rice, (eds). Tulsa, Oklahoma. pp. 287-302 and pp. 341-359.

Seacross Enterprises. 2002. Wildlife Communities of the Powder River Basin: a Baseline Document to Assist in Evaluating Impacts of Coal Bed Methane Development. Unpublished document prepared by Seacross Enterprises, Gillette, Wyoming.

Sheridan County. 2001a. Draft Vision 2020: Sheridan County Growth Management Plan. Sheridan County, Sheridan, Wyoming. Adopted May 7, 2001.

_____. 2001b. Sheridan County Zoning Resolution. Sheridan County, Sheridan, Wyoming. Adopted May, 2001.

_____. 1999. Sheridan County, Wyoming Comprehensive Land Use Plan. Sheridan County Planning Department. Sheridan, Wyoming. Adopted October 1980, updated 1999.

Shorma, G. 2005. Regional Supervisor, Wyoming Game and Fish Department, Sheridan, Wyoming. Personal communication with B. Strom, ENSR. May 20, 2005.

Smith, J. B. and W. A. Hubert. 1989. Use of a Tributary by Fishes in a Great Plains River System. Prairie Naturalist 21: 27-38.

Stalmaster, M. V. and J. R. Newman. 1978. Behavioral Responses of Wintering Bald Eagles to Human Activity. Journal of Wildlife Management 42(3):506-513.

Stanton, K. 2004. Range and Management Specialist, Douglas Ranger District, Medicine Bow-Routt National Forests and Thunder Basin National Grasslands. Grazing information for the northern part of the TBNG provided to J. Alstad, ENSR. October 12, 2004.

State of Wyoming. 2002. Title 11 Agriculture, Livestock and Other Animals. Chapter 16 Wyoming Conservation Districts Law. §11-16-103. 18 pages.

Stebbins, R. C. 1985. A Field Guide to Western Reptiles and Amphibians. Second edition. Houghton Mifflin Company, Boston, Massachusetts.

Steidtmann, J. R. 1993. The Lower Cretaceous Foreland Basin and its Sedimentary Record. In: Geology of Wyoming, Vol. 1. Snoke and others, eds. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. pp. 251-271.

Stephens, J. R. Jr. 1975. Soil Survey of Johnson County, Wyoming, Southern Part. Soil Conservation Service in cooperation with the Wyoming Agricultural Experiment Station.

Stewart, B. 1996. Little Powder Basin Management Plan (FXSN8LP). Wyoming Game and Fish Department, Sheridan, Wyoming.

_____. 1995. Tongue River Basin Management Plan. Wyoming Game and Fish Department, Sheridan, Wyoming.

Stratham, A. 2005. Wyoming Game and Fish Department. Personal communication with B. Strom, ENSR. May 12, 2005.

Stricker, G. D. and M. S. Ellis. 1999. Coal Quality and Geochemistry, Powder River Basin, Wyoming and Montana. In: Fort Union Assessment Team, 1999, Resource Assessment of Selected Tertiary Coal Beds and Zones in the Northern Rocky Mountains and Great Plains Region. U.S. Geological Survey Professional Paper 1625-A, Chapter PQ.

Swanson, G. A., V. A. Adomeitis, F. B. Lee, J. R. Serie, and J. A. Shoesmith. Limnological Conditions Influencing Duckling Use of Saline Lakes in South-central North Dakota. Journal of Wildlife Management 48:340-349.

Swisher, J. F. 1964. A Roosting Area of the Bald Eagle in Northern Utah. Wilson Bulletin 76(2):186-187.

Terres, J. K. 1980. The Audubon Society Encyclopedia of North American Birds. Alfred A. Knopf. New York, New York.

Thomas, T. 2005. Wildlife Biologist, Wyoming Game and Fish Department, Sheridan Regional Office, Sheridan, Wyoming. Personal commuinication with A. Grow, ENSR. May 16, 2005.

Thompson, S. P., R. S. Johnson, and C. D. Littlefield. 1982. Nesting History of Golden Eagles in Malheur Harney Lakes Basin, Southeastern Oregon. Journal of Raptor Research 16(4):116-122.

Thunder Basin Coal Company. 2003. 2002-2003 Coal Creek Mine Annual Report. Permit No. 483-T4. February 2003.

Town of Wright. 1998. Town of Wright Master Plan Revision. Town of Wright, Wyoming. December 1998.

Tribbey, B. 1988. Biological Assessment of Evaporation Ponds. U.S. Soil and Conservation Service, Kings River Conservation District. California State University, Fresno, California. 102 pp.

Udvardy, M. D. 1977. The Audubon Society Field Guide to North American Birds, Western Region. Alfred A. Knopf Publishing, New York, New York.

University of Wyoming. 2002. Wyoming Natural Resources Clearinghouse — Data Atlas. Terrestrial Vertebrate Species Richness in Wyoming [Web Page]. Internet web site: http://www.wygisc.uwyo.edu/24k/vert.html. Accessed: August 6, 2002.

_____. 1998. Atlas of the Vascular Flora of Wyoming. Rocky Mountain Herbarium. Internet web site: http://www.rmh.uwyo.edu. Accessed May 6, 2005.

Unruh, J. D., Jr., 1982. The Plains Across: The Overland Emigrants and the Trans-Mississippi West, 1840-60. University of Illinois Press, Urbana and Chicago, Illinois.

U.S. Army Corps of Engineers (USACE). 2002. Three Oaks Mine, Draft Environmental Impact Statement. Fort Worth District, Fort Worth, Texas. August 2002.

U.S. Department of Agriculture (USDA). 2004. Wyoming Agricultural Statistics 2003. U.S. Department of Agriculture, National Agricultural Statistics Service, Wyoming Statistical Office, Cheyenne, Wyoming. Internet web site: http://www.nass.usda.gov/wy/.

U.S. Environmental Protection Agency. 2002. Draft Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs. EPA Office of Water, EPA 816-D-02-006.

U.S. Fish and Wildlife Service (USFWS). 2003. Withdrawal of the Proposed Rule to List the Mountain Plover as Threatened Mountain Plover; withdrawn (*Charadrius montanus*) 09/2003 RIN 1018-AI45. 50 CFR Part 17 68 FR 53083 53083-53101 09/.

_____. 2002a. Review of Species that Are Candidates or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Recycled Petitions; Annual Description of Progress on Listing Actions. Federal Register 67(114): 40657-40679. June 13, 2002.

_____. 2002b. Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances. Prepared by L. A. Romin and J. A. Muck. Utah Field Office, Salt Lake City, Utah. 42 pp. January 2002 (update).

_____. 2001a. Annual Notice of Findings on Recycled Petitions. Federal Register 66(5): 1295-1300. January 8, 2001.

_____. 2001b. 12-month Finding for a Petition to List the Sicklefin Chub (*Macrhybopsis meeki*) and the Sturgeon Chub (*Macrhybopsis gelida*) as Endangered. Federal Register 66(75): 19910-19914. April 18, 2001.

_____. 2000. 12-Month Finding for a Petition to List the Black-Tailed Prairie Dog as Threatened. February 4, 2000. Federal Register 65(24): pp. 5476-5488.

_____. 1999a. ETWP; Proposed Rule to Remove the Bald Eagle in the Lower 48 States From the List of Endangered and Threatened Wildlife. 50 CFR Part 17 64 FR 47755-47756 47755-47756 09/01/1999 RIN 1018-AC48.

_____. 1999b. Proposed Threatened Status for the Mountain Plover. Federal Register 64(30):7587–7601. February 16, 1999.

_____. 1999c. Final Rule to Remove the American Peregrine Falcon From the Federal List of Endangered and Threatened Wildlife, and to Remove the Similarity of Appearance Provision for Free-flying Peregrines in the Conterminous United States. Federal Register 64(164):46542–46558. August 25, 1999.

_____. 1998. Final Rule to List the Preble's Meadow Jumping Mouse as a Threatened Species. Federal Register 63 (92): 26517-26530. May 13, 1998.

_____. 1995. Final Rule to Reclassify the Bald Eagle from Endangered to Threatened in All of the Lower 48 States. Federal Register 60(133): 36000–36010. July 12, 1995.

_____. 1992. Final Rule to List the Plant *Spiranthes diluvialis* (Ute Ladies'-Tresses) as a Threatened Species. January 17, 1992. Federal Register 57 (12): 2048-2053.

_____. 1989. Black-footed Ferret Survey Guidelines for Compliance with the Endangered Species Act. April 1989.

_____. 1988. Black-footed Ferret Recovery Plan. U.S. Fish and Wildlife Service, Denver, Colorado. 154 pp.

_____. 1978. Determination of Certain Bald Eagle Populations as Endangered or Threatened Federal Register, Vol 43, No. 31 – Tuesday. February 14, 1978.

_____. 1970. Final Rule to List Animal *Mustela nigripes* (black-footed ferret) as an Endangered Species. Federal Register 35 FR 8491–8498.

U.S. Forest Service (USFS). 2002. Record of Decision for the Final Environmental Impact Statement and Land and Resource Management Plan for the Thunder Basin National Grassland, Medicine Bow-Routt National Forest. USDA, Rocky Mountain Regional Office, Denver, Colorado. July 31, 2002.

_____. 2001a. Land and Resource Management Plan for the Thunder Basin National Grassland. USDA. Medicine Bow-Routt National Forest. Laramie, Wyoming. 2001. Internet web site: http://www.fs.fed.us/ngp/final/pdf_plan_final/Thunder_Basin_Plan/titlepage.pdf. Accessed September 13, 2001.

_____. 2001b. Final Environmental Impact Statement for the Northern Great Plains Management Plans Revision. USDA, Northern Great Plains Planning Team. Chadron, Nebraska. Internet web site: http://www.fs.fed.us/r2/mbr/ projects/forestplans/thunderbasin/pdfdoc/chapterapp/ title_page.pdf. May 2001.

_____. 1995. Landscape Aesthetics: A Handbook for Scenery Management. (Agriculture Handbook Number 701). U.S. Department of Agriculture. Washington, D.C. December 1995.

_____. 1986. ROS Book. USDA. Washington, D.C.

U.S. Forest Service and Bureau of Land Management (USFS and BLM). 2003. Environmental Assessment of Gunnison Energy Corporation's Proposed Exploratory Gas Drilling Project. May 2003.

U.S. Geological Survey (USGS). 2004. Quaternary Fault and Fold Database for the United States. Internet web site: http://geohazards.cr.usgs.gov/qfaults/wy/roc.html.

_____. 2003a. Sage Grouse and WNV Fact Sheet. Internet web site: http://www.sagemap.wr.usgs.gov. October 24, 2003.

_____. 2003b. The Mineral Industry of Wyoming. In: U.S. Geological Survey Minerals Yearbook - 2002. Volume II Area Reports Domestic, pp. 531-533.

_____. 2002. Assessment of Undiscovered Oil and Gas Resources of the Powder River Basin Province of Wyoming and Montana, 2002. USGS Fact Sheet FS-146-02. November 2002.

_____. 2001. Boreal Toad Homepage [Web Page]. Internet web site: http://www.mesc.usgs.gov/ borealtoad. Accessed July 3, 2001. Updated internet web site: http://www.mesc.usgs.gov/ resources/education/borealtoad. Accessed September 17, 2002.

_____. 1970. The National Atlas of the United States of America. U.S. Geological Survey, U.S. Department of the Interior. Washington, D.C. 470 pp.

Vaillancourt, D. A. 1995. Structural and Microclimatic Edge Effects Associated with Clearcutting in a Rocky Mountain Forest. MA Thesis, University of Wyoming, 57 pp.

Van Horn, M. D. and L. T. Shannon. 1989. Hay Reservoir Field: A Submarine Fan Gas Reservoir Within the Lewis Shale, Sweetwater County, Wyoming. In: Eisert, J. L., ed, 1992, Gas Resources of Wyoming, Wyoming Geological Association 40th Field Conference Guidebook, Casper, Wyoming. pp. 155-180.

Wagner, G. 1997. Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 9, Edmonton, AB. 46 pp.

Ward, A. L. 1976. Elk Behavior in Relation to Timber Harvest Operations and Traffic on the Medicine Bow Range in South-central Wyoming. In: Proceedings Elk-logging-roads Symposium, ed. S. R. Hieb. pp. 32-43. Moscow, University of Idaho. 142 pp.

Ward, A. L., N. E. Fornwalt, S. E. Henry, and R. A. Hodorff. 1980. Effects of Highway Operation Practices and Facilities on Elk, Mule Deer, and Pronghorn Antelope. Report No. FHWA-RD-79-143. National Technical Information Service, Springfield, Virginia. 48 pp. (or USDT-Fed. Highway Administration Report No. FHWA-RD-79-143. 48 pp.)

Watson, J. E. 1980. Catalog of Wyoming Stratigraphy. Tooke Engineering, Casper, Wyoming. (not paginated).

Water Resources Data System. 2004. Interactive Geologic, Hydrologic, and Water Quality Database and Model of the Northern Powder River Basin, Wyoming. Produced by the Wyoming State Geological Survey and the Water Resources Data System for the State of Wyoming. Internet web site: http://ims.wrds.uwyo.edu/prb/index.html.

Welp, L., W. F. Fertig, G. P. Jones, G. P. Beauvais, and S. M. Ogle. 2000. Fine Filter Analysis of the Bighorn, Medicine Bow, and Shoshone National Forests in Wyoming. Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming.

Westerman, J. W. and C. Prink. 2004 Soil Survey of Campbell County, Wyoming, Southern Part. Natural Resources Conservation Service in cooperation with the BLM, USFS, and Wyoming Agricultural Experiment Station.

Western EcoSystems Technology, Inc. 2004. 2004 Annual Report – Sublette Mule Deer Study (Phase II): Long-term Monitoring Plan to Assess Potential Impacts of Energy Development on Mule Deer in the Pinedale Anticline Project Area. Prepared for Questar Exploration and Production Company, TRC Mariah Associates, Inc., the Bureau of Land Management, and the Wyoming Game and Fish Department. 55 pp. November 2004.

Whitaker, J. O., Jr. 1963. A Study of the Meadow Jumping Mouse, *Zapus hudsonius* (Zimmerman), in Central New York. Ecological Monographs 33:3.

White, C. M. and T. L. Thurow. 1985. Reproduction of Ferruginous Hawks Exposed to Controlled Disturbance. Condor 87:14-22.

Wiley, B. 2001. Fisheries Management Coordinator, Wyoming Game and Fish Department, Cheyenne, Wyoming. Personal communication with (email) to Steven Faulk, Greystone Environmental Consultants, regarding Basin Management Plans for Sheridan and Casper Regions. November 21, 2001.

Windingstad, R. M., R. X. Kartch, R. K. Stroud, and M. R. Smith. 1987. Salt Toxicosis in Waterfowl in North Dakota. Journal of Wildlife Diseases 23(3):443-446.

Winn, R. 1998a. American Kestrel. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 126-127. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

_____. 1998b. Flammulated Owl. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. Colorado pp. 210-211. Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Winnecke, G. J. 2003. Future Oil Prices Likely Higher Than Historic $18-22/bbl Consensus. Oil and Gas Journal, September 29, 2003, pp. 30-37.

Wobeser, G. and J. Howard. 1987. Mortality of Waterfowl on a Hypersaline Wetland as a Result of Salt Encrustation. Journal of Wildlife Diseases 23(1):127-134.

Wolfbauer, C. A. 1976. Bentonite in the Powder River Basin, Wyoming. In: Geology and Energy Resources of the Powder River. R. B. Laudon, editor. pp. 257–259. Wyoming Geological Association 28th Annual Field Conference Guidebook.

Woodling, J. 1985. Colorado's Little Fish. A Guide to the Lesser Known Fishes in the State of Colorado. Colorado Division of Wildlife, Denver, Colorado. 77 pp.

Wyoming Bioinformation Node (WBN). 2002. Black Hills Redbelly Snake. Internet web site: http://www.wygisc.uwyo.edu/cgi-bin/wbn/atlas.cgi?ID=aradb34033& TYPE=map. Accessed July 26, 2002.

Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LQD). 1994. Guideline No.1 "Topsoil and Overburden." Cheyenne, Wyoming. Rules Update, 8-94.

Wyoming Department of Transportation (WYDOT). 2004. FY 2005 State Transportation Improvement Program. Internet web site: http://dot.state.wy.us/generic/business/ STIP/stip.pdf.

_____. 1999. Vehicle Miles 1999. Wyoming Department of Transportation, Transportation Planning Program, Cheyenne, Wyoming.

Wyoming Game and Fish Department (WGFD). 2003. Annual Fisheries Progress Report on the 2002 Work Schedule. Regional/Statewide Aquatic Wildlife Management and Aquatic Habitat Management. Cheyenne, Wyoming.

_____. 2002a. Draft Wyoming Greater Sage-Grouse Conservation Plan. July 10, 2002. Internet web site: http://gf.state.wy.us/html/sagegrouse.htm. Accessed August 2, 2002.

_____. 2002b. Sheridan Region Annual Big Game Herd Unit Reports. Wyoming Game and Fish Department, Cheyenne, Wyoming.

_____. 2002c. Casper Region Annual Big Game Herd Unit Reports 2002. Wyoming Game and Fish Department, Cheyenne, Wyoming.

_____. 2002d. Annual Fisheries Progress Report on the 2001 Work Schedule. Regional/Statewide Aquatic Wildlife Management and Aquatic Habitat Management. Cheyenne, Wyoming.

_____. 2001. Annual Fisheries Progress Report on the 2000 Work Schedule. Regional/Statewide Aquatic Wildlife Management and Aquatic Habitat Management. Cheyenne, Wyoming.

_____. 1999. Status and Management of Yellowstone Cutthroat Trout *Oncorhynchus clarki bouvieri*, WGFD, Cheyenne, Wyoming, 56 pp.

Wyoming Mining Association. 2004. Internet web site: http://www.wma-minelife.com/. Accessed June 16, 2004.

Wyoming Oil and Gas Conservation Commission (WOGCC). 2004. Wyoming Statistics Internet web site: http://wogcc.state.wy.us/cfdocs/2002stats.htm.

Wyoming Office of State Lands and Investments. 1996. Final Report and Recommendations of the Select Committee on State Trust Lands. Wyoming Office of State Lands and Investments. Cheyenne, Wyoming. November 15, 1996.

_____. No date. Wyoming Statistics. Internet web site: http://wogcc.state.wy.us/coalbedchart.cfm.

Wyoming State Historic Preservation Office. 2005. Internet web site: www.wyoshpo.state.wy.us.htm.

Yaeger, M. 1998. American Bittern. In: Colorado Breeding Bird Atlas. H. E. Kingery, ed. pp. 52-53. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Denver, Colorado.

Zinn, J. A. and C. Copeland. 2001. Wetland Issues. Congressional Research Service Issue Brief. Publication IB97014. Resources, Science, and Industry Division, Washington, DC. 12 pp. March 14, 2001.

APPENDIX A

SOILS

Table-A-1
Soil Series Characteristics

Map Unit	Major Soil Series	Surface Texture	Slope Range	Severe Wind Erosion Hazard	Severe Water Erosion Hazard	Severe Shrink-swell Potential	Salinity	Prime Agricultural Soils	Poor Revegetation Potential
WY002	Midway	Silty Clay Loam	2-35 percent						
	Samday	Clay Loam	2-45 percent		X	X			X
	Rock Outcrop	--	--						X
WY004	Haverson	Loam	0-6 percent					X	
	Glenberg	Fine Sandy Loam	0-3 percent					X	
	Bone	Clay Loam	0-6 percent			X	X		
WY042	Cabbart	Loam	2-75 percent						X
	Yawdim	Silty Clay	2-70 percent		X	X			X
	Hesper	Silty Clay Loam	0-15 percent						
WY043	Ridge	Sandy Loam	4-65 percent				NR		
	Broadus	Loam	8-65 percent				NR		
	Reeder	Loam	2-25 percent						
WY044	Havre	Loam	0-6 percent						
	Hanly	Fine Sandy Loam	0-6 percent						
	Glendive	Loam	0-8 percent						
WY045	Cabbart	Loam	2-75 percent						X
	Yawdim	Silty Clay	2-70 percent		X	X			X
	Thurlow	Silty Clay Loam	0-15 percent						
WY046	Cabba	Silty Loam	15-50 percent		X*				X
	Ringling	Channery Loam	8-95 percent						X
	Yawdim	Silty Clay	2-70 percent		X	X			X
WY047	Draknab	Fine Sandy Loam	0-4 percent	X					
	Arvada	Clay Loam	0-6 percent			X			
	Bidman	Loam	0-15 percent			X			
WY048	Riverwash	--	--						
	Haverdad	Fine Sandy Loam	0-6 percent					X	
	Clarkelen	Loam	0-3 percent						
WY049	Shingle	Clay Loam	0-80 percent		X*				X
	Renohill	Clay Loam	3-25 percent		X*	X			
	Forkwood	Clay Loam	0-15 percent					X	
WY050	Shingle	Loam	10-40 percent		X*				X
	Taluce	Sandy Loam	15-40 percent						X
	Kishona	Loam	3-6 percent						
WY051	Wyarno	Clay Loam	0-9 percent			X			
	Hargreave	Fine	3-15 percent						
		Sandy Loam							
	Moskee	Fine Sandy Loam	0-45 percent		X*			X	

Table A-1 (Continued)

Map Unit	Major Soil Series	Surface Texture	Slope Range	Severe Wind Erosion Hazard	Severe Water Erosion Hazard	Severe Shrink-swell Potential	Salinity	Prime Agricultural Soils	Poor Revegetation Potential
WY053	Shingle	Loam	2-60 percent		X*				X
	Cushman	Clay Loam	0-15 percent						
	Taluce	Fine Sandy Loam	3-30 percent						X
WY055	Haverdad	Fine Sandy Loam	0-6 percent					X	
	Havre	Loam	0-6 percent						
	Zigweid	Loam	0-15 percent					X	
WY056	Samday	Clay Loam	2-60 percent		X*	X			X
	Shingle	Loam	2-60 percent		X*				X
	Rock Outcrop	--	--						X
WY057	Doney	Silt Loam	6-90 percent		X*				X
	Shaak	Loam	0-6 percent			X			
	Wayden	Silty Clay	0-35 percent		X*	X			
WY058	Abac	Silt Loam	9-35 percent						X
	Peritsa	Silt Loam	9-35 percent						
	Rock Outcrop	--	--						X
WY059	Rock Outcrop	--	--						X
	Starley	Loam	10-60 percent						X
	Woosley	Loam	2-15 percent		X*				
WY060	Tolman	Channery Loam	5-70 percent						X
	Abac	Silt Loam	9-35 percent						X
	Rock Outcrop	--	--						X
WY061	Agneston	Coarse Sandy Loam	10-50 percent						X
	Rock Outcrop	--	--						X
	Granile	Coarse Sandy Loam	10-50 percent						
WY062	Owen Creek	Clay Loam	9-30 percent			X			
	Tongue River	Silty Loam	2-60 percent	X	X*		NR		
	Gateway	Loam	6-50 percent	X		X	NR		X
WY063	Wolf	Loam	0-3 percent						
	Platner	Clay Loam	0-25 percent			X			
	Platsher	Loam	0-3 percent			X			
WY064	Platsher	Loam	0-3 percent			X			
	Recluse	Loam	3-6 percent					X	
	Parmleed	Sandy Loam	3-9 percent			X			
WY065	Baux	Loam	3-60 percent		X*				X
	Bauxson	Channery Loam	3-60 percent		X*				X
	Harlan	Loam	0-15 percent		X*			X	
WY066	Moskee	Fine Sandy Loam	0-45 percent		X*			X	
	Hargreave	Fine	3-15 percent						
		Sandy Loam							

Table A-1 (Continued)

Map Unit	Major Soil Series	Surface Texture	Slope Range	Severe Wind Erosion Hazard	Severe Water Erosion Hazard	Severe Shrink-swell Potential	Salinity	Prime Agricultural Soils	Poor Revegetation Potential
	Shingle	Loam	2-60 percent		X*				X
WY078	Frisco	Sandy Loam	2-70 percent				NR		
	Troutville	Coarse Sandy Loam	2-60 percent				NR		X
	Teewinot	Gravelly Loam	5-70 percent	X			NR		X
WY081	Barnum	Fine Sandy Loam	0-3 percent					X	
	Haverdad	Loam	0-3 percent					X	
	Rock Outcrop	--	--						X
WY082	Renohill	Clay Loam	3-12 percent			X			
	Shingle	Loam	3-45 percent						X
	Parmleed	Sandy Loam	3-9 percent			X			
WY084	Keyner	Sandy Loam	0-6 percent				X		
	Samday	Clay Loam	3-12 percent			X			X
	Rock Outcrop	--	--						X
WY085	Samday	Clay Loam	3-12 percent			X			X
	Badland	--	--						X
	Rock Outcrop	--	--						X
WY086	Cambria	Fine Sandy Loam	2-15 percent						
	Shingle	Loam	3-45 percent						X
	Kishona	Loam	10-30 percent						
WY087	Shingle	Loam	3-45 percent						X
	Cambria	Fine Sandy Loam	2-15 percent						
	Renohill	Clay Loam	3-12 percent			X			
WY088	Sunup	Gravelly Loam	10-30 percent						X
	Rock Outcrop	--	--						X
	Spearfish	Fine Sandy Loam	10-30 percent						X
WY114	Tassel	Fine Sandy Loam	2-30 percent						X
	Turnercrest	Sandy Loam	6-30 percent						
	Terro	Sandy Loam	2-10 percent						
WY115	Shingle	Loam	6-30 percent						X
	Samday	Clay Loam	2-45 percent		X*	X			X
	Absted	Fine Sandy Loam	0-6 percent			X	X		
WY124	Platsher	Loam	0-9 percent			X			
	Kishona	Loam	0-15 percent						
	Hiland	Sandy Loam	3-15 percent	X				X	
WY125	Shingle	Clay Loam	0-75 percent						X
	Theedle	Loam	3-40 percent						
	Wibaux	Gravelly Loam	0-75 percent						X
WY126	Hiland	Sandy Loam	0-15 percent	X				X	
	Vonalee	Sandy Loam	0-15 percent	X					

Table A-1 (Continued)

Map Unit	Major Soil Series	Surface Texture	Slope Range	Severe Wind Erosion Hazard	Severe Water Erosion Hazard	Severe Shrink-swell Potential	Salinity	Prime Agricultural Soils	Poor Revegetation Potential
	Maysdorf	Sandy Loam	0-15 percent						
WY127	Kishona	Loam	0-15 percent						
	Shingle	Clay Loam	0-75 percent						X
	Theedle	Loam	3-40 percent						
WY128	Renohill	Clay Loam	3-15 percent			X			
	Cushman	Loam	0-15 percent						
	Cambria	Loam	0-9 percent						
WY129	Bidman	Loam	0-9 percent			X			
	Parmleed	Loam	3-15 percent			X			
	Renohill	Clay Loam	3-15 percent			X			
WY130	Renohill	Clay Loam	3-15 percent			X			
	Bidman	Loam	0-6 percent			X			
	Ulm	Clay Loam	0-6 percent			X		X	
WY204	Hiland	Sandy Clay Loam	0-15 percent					X	
	Ustic Torriorthents	Loamy Sand	3-30 percent						
	Bowbac	Sandy Loam	0-15 percent						
WY203	Clarkelen	Sandy Loam	0-3 percent						
	Draknab	Loamy Sand	0-3 percent	X					
	Haverdad	Fine Sandy Loam	0-3 percent					X	
WY205	Dwyer	Loamy Sand	0-15 percent	X					X
	Orpha	Loamy Sand	0-15 percent	X					
	Hiland	Sandy Clay Loam	0-15 percent					X	
WY206	Wibaux	Channery Loam	0-45 percent						X
	Rock Outcrop	--	--						X
	Shingle	Clay Loam	3-45 percent		X*				X
WY207	Hiland	Sandy Clay Loam	0-15 percent					X	
	Bowbac	Sandy Loam	0-15 percent	X					
	Tassel	Fine Sandy Loam	10-30 percent	X					X
WY208	Shingle	Clay Loam	3-45 percent		X*				X
	Samday	Clay Loam	3-30 percent			X			X
	Hiland	Sandy Clay Loam	0-15 percent					X	
WY209	Hiland	Sandy Clay Loam	0-15 percent					X	
	Shingle	Clay Loam	3-45 percent		X*				X
	Tassel	Fine Sandy Loam	10-30 percent	X					X
WY210	Ulm	Loam	0-15 percent			X		X	
	Renohill	Fine Sandy Loam	0-15 percent			X			
	Shingle	Clay Loam	3-45 percent		X*				X
WY211	Shingle	Clay Loam	3-45 percent		X*				X

Table A-1 (Continued)

Map Unit	Major Soil Series	Surface Texture	Slope Range	Severe Wind Erosion Hazard	Severe Water Erosion Hazard	Severe Shrink-swell Potential	Salinity	Prime Agricultural Soils	Poor Revegetation Potential
	Tassel	Fine Sandy Loam	10-30 percent	X					X
	Rock Outcrop	--	--						X
WY315	Rock Outcrop	--	--						X
	Hazton	Gravelly Sandy Loam	10-40 percent						X
	Redsun	Channery Loam	3-30 percent						X
WY316	Hiland	Sandy Loam	0-15 percent	X				X	
	Bowbac	Loamy Fine Sand	3-15 percent						
	Keyner	Sandy Clay Loam	0-12 percent				X		
WY317	Shingle	Loam	3-45 percent		X*				X
	Taluce	Sandy Loam	6-40 percent						X
	Amodac	Fine Sandy Loam	2-12 percent				X		
WY321	Hiland	Sandy Loam	0-15 percent	X				X	
	Orpha	Loamy Sand	3-45 percent	X					
	Bowbac	Loamy Fine Sand	3-15 percent						
WY322	Roughlock	Loam	0-15 percent						
	Rock Outcrop	--	--						X
	Rekop	Loam	5-40 percent						X
WY323	Lolite	Clay	5-50 percent		X	X			X
	Hiland	Sandy Loam	0-15 percent	X				X	
	Vonalee	Loamy	3-15 percent	X					
		Sand							
WY324	Hiland	Sandy Loam	0-15 percent	X				X	
	Forkwood	Loam	0-12 percent					X	
	Zigweid	Loam	2-15 percent					X	
WY325	Lolite	Clay	5-50 percent		X	X			X
	Rock Outcrop	--	--						X
	Keyner	Sandy Clay Loam	0-12 percent				X		

Source: BLM 2003a.

Note: The * and NR were not defined in the original table in the PRB Oil and Gas Final EIS (BLM 2003).

APPENDIX B

FISHERIES

Table B-1
Occurrence of Fish Species by Subwatershed

Fish Species		Subwatershed																	
Common Name (scientific name)	**Wyoming Native Species Status[3]**	**Little Bighorn River[2]**	**Upper Tongue River[1,2]**	**Middle Fork Powder River[1,2]**	**North Fork Powder River[4]**	**Upper Powder River[1,2]**	**South Fork Powder River[1]**	**Salt Creek[1]**	**Crazy Woman Creek[1]**	**Clear Creek[1]**	**Middle Powder River[1]**	**Little Powder River[1,2]**	**Little Missouri River[1,2]**	**Antelope Creek[4]**	**Dry Fork Cheyenne River[4]**	**Upper Cheyenne River[2]**	**Lightning Creek[4]**	**Upper Belle Fourche River[1,2]**	**Middle North Platte[4]**
Black bullhead (*Ameirus melas*)(N)	NSS3		X			X					X	X				X		X	
Brassy minnow (*Hybognathus hankinsoni*)(N)	NSS6									X									
Brook trout (*Salvelinus fontinalis*)(I)		X	X	X	X	X	X		X	X		X							
Brown trout (*Salmo trutta*)(I)		X	X	X	X	X	X		X	X									
Channel catfish (*Ictalurus punctatus*)(N)	NSS4		X			X			X		X	X							
Common carp (*Cyprinus carpio*)(I)			X			X			X	X	X	X				X		X	
Creek chub (*Semotilus atromaculatus*)(N)	NSS5		X				X			X								X	
Cutthroat trout (*Salmo clarki*)(N)		X																	
Fathead minnow (*Pimephales promelas*)(N)	NSS6	X	X			X	X	X	X	X	X	X		X		X		X	
Flathead chub (*Platygobio gracilis*)(N)	NSS3	X	X	X		X	X	X	X	X	X	X		X		X			
Golden shiner (*Notemigonus crysoleucas*)(I)			X																
Goldeye (*Wiodon alosodies*)(N)	NSS2					X			X	X	X	X							

Table B-1 (Continued)

Fish Species		Subwatershed																	
Common Name (scientific name)	**Wyoming Native Species Status[3]**	**Little Bighorn River[2]**	**Upper Tongue River[1,2]**	**Middle Fork Powder River[1,2]**	**North Fork Powder River[4]**	**Upper Powder River[1,2]**	**South Fork Powder River[1]**	**Salt Creek[1]**	**Crazy Woman Creek[1]**	**Clear Creek[1]**	**Middle Powder River[1]**	**Little Powder River[1,2]**	**Little Missouri River[1,2]**	**Antelope Creek[4]**	**Dry Fork Cheyenne River[4]**	**Upper Cheyenne River[2]**	**Lightning Creek[4]**	**Upper Belle Fourche River[1,2]**	**Middle North Platte[4]**
Green sunfish (*Lepomis cyanellus*) (I)			X								X	X				X		X	
Lake chub (*Couesius plumbeus*) (N)	NSS3		X									X						X	
Largemouth bass (*Micropterus salmoides*) (I)												X							
Longnose dace (*Rhinichthys cataractae*) (N)	NSS7	X	X	X		X	X	X	X	X	X	X				X			
Longnose sucker (*Catostomus catostomus*) (N)	NSS4		X	X					X	X	X	X							
Mountain sucker (*Catostomus platyrhynchus*)(N)	NSS3		X	X		X	X		X		X	X							
Mountain whitefish (*Prosopium williamsoni*) (N)	NSS4		X																
Northern redhorse (*Maxostoma macrolepidotum*)(N)	NSS4		X			X			X	X	X	X							
Plains killifish (*Fundulus zebrinus*)(N)	NSS6					X	X							X		X			
Plains minnow (*Hybognathus placitus*)(N)	NSS3		X			X	X	X		X	X	X				X		X	
Quillback (*Carpiodes cyprinus*)(N)	NSS4					X													
Rainbow trout (*Oncorhynchus mykiss*)(I)		X	X									X							
River carpsucker (*Carpiodes carpio*)(N)	NSS4					X			X	X	X	X				X			

Table B-1 (Continued)

Fish Species		Subwatershed																	
Common Name (scientific name)	**Wyoming Native Species Status[3]**	**Little Bighorn River[2]**	**Upper Tongue River[1,2]**	**Middle Fork Powder River[1,2]**	**North Fork Powder River[4]**	**Upper Powder River[1,2]**	**South Fork Powder River[1]**	**Salt Creek[1]**	**Crazy Woman Creek[1]**	**Clear Creek[1]**	**Middle Powder River[1]**	**Little Powder River[1,2]**	**Little Missouri River[1,2]**	**Antelope Creek[4]**	**Dry Fork Cheyenne River[4]**	**Upper Cheyenne River[2]**	**Lightning Creek[4]**	**Upper Belle Fourche River[1,2]**	**Middle North Platte[4]**
Rock bass (*Ambloplites rupestris*)(I)			X			X													
Sand shiner (*Notropis stramineus*)(N)	NSS7		X			X	X	X	X X	X	X	X		X		X		X	
Sauger (*Stizostedion canadense*)(N)	NSS2		X			X													
Shovelnose sturgeon (*Scaphirhynchus platorynchus*)(N)						X			X										
Silvery minnow (*Hybognathus nuchalis*)(N)	NSS1										X	X							
Smallmouth bass (*Micropterus dolomieui*)(I)			X							X									
Snake River cutthroat trout (*Oncorhynchus clarki ssp.*)(N)	NSS4		X																
Stonecat (*Notorus flavus*)(N)	NSS4		X	X		X			X	X	X	X							
Sturgeon chub (*Macrhybopsis gelida*)(N)	NSS1					X													
Walleye (*Stizostedion vitreum*)(I)			X																
White crappie (*Pomoxis annularis*)(I)			X																
White sucker (*Catostomus commersoni*)(N)	NSS7		X	X		X	X	X	X	X	X	X						X	

Table B-1 (Continued)

Fish Species		Subwatershed																	
Common Name (scientific name)	**Wyoming Native Species Status[3]**	**Little Bighorn River[2]**	**Upper Tongue River[1,2]**	**Middle Fork Powder River[1,2]**	**North Fork Powder River[4]**	**Upper Powder River[1,2]**	**South Fork Powder River[1]**	**Salt Creek[1]**	**Crazy Woman Creek[1]**	**Clear Creek[1]**	**Middle Powder River[1]**	**Little Powder River[1,2]**	**Little Missouri River[1,2]**	**Antelope Creek[4]**	**Dry Fork Cheyenne River[4]**	**Upper Cheyenne River[2]**	**Lightning Creek[4]**	**Upper Belle Fourche River[1,2]**	**Middle North Platte[4]**
Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*)(N)	NSS2		X																
Yellow perch (*Perca flavescens*)(I)			X																

Source: BLM 2003a; Gerard 2005.

Notes:

1. Data from Patton (1997).
2. Data from Wyoming Game and Fish Basin Management Plans (Wiley 2001). (I) = Introduced species in Wyoming. (N) = Native species in Wyoming.
3. Status 1 Species – Populations are physically isolated and/or exist at extremely low densities throughout range. Habitats are declining or vulnerable. Extirpation appears possible. The Wyoming Game and Fish Commission mitigation category is "Vital." The mitigation objective for this resource category is to realize "no loss of habitat function." Under these guidelines, it would be very important that the project be conducted in a manner that avoids alteration of habitat function. Status 2 Species - Populations are physically isolated and/or exist at extremely low densities throughout range. Habitat conditions appear stable. The Wyoming Game and Fish Commission mitigation category is "Vital." Status 3 Species – Populations are widely distributed throughout its native range and appear stable. However, habitats are declining or vulnerable. The Wyoming Game and Fish Commission mitigation category is "High." The mitigation objective for this category is to realize "no net loss of habitat function within the biological community which encompasses the project site." Under these guidelines, it would be important that the project be conducted in a manner that avoids the impact, enhances similar habitats, or results in the creation of an equal amount of similarly valued fishery habitat. Status 4-7 Species – Populations are widely distributed throughout native range and are stable or expanding. Habitats are also stable. There is no special concern for these species.
4. Data from Commonwealth Associations, Inc. (1980).
5. Occurrence data provided by WGFD.